THE MINERAL WATERS OF EUROPE.

TICHBORNE & PROSSER JAMES

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THE

MINERAL WATERS

OF

EUROPE:

INCLUDING

A SHORT DESCRIPTION OF ARTIFICIAL MINERAL WATERS.

BY

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PREFACE.

Most of the objects had in view in writing the present work have been incidentally mentioned in the Introductory Chapter. It may, however, be desiderable to enumerate concisely the chief points which have actuated the authors in penning the "Mineral Waters of Europe."

The book is intended as a reliable work of reference in connection with the chief mineral waters, and also to give the character and locality of such other waters as are in use.

In many of the books published upon the subject the analyses given do not represent the present composition of the waters. They have been copied from work to work for years. Not only has every error been transmitted with the most religious fidelity, but,

in some cases, they are merely copies of interested puffs, carrying with them little or no weight.

We have endeavoured to avoid these rocks a-head. In all the chief waters we have either re-examined the bottled waters ourselves, or have made use of recent analyses performed by analysts whose names were a guarantee.

The new analyses are nearly one hundred in number, and represent work which has extended over a period of about three years.

We frequently meet with a class of books dealing with the individual experience of an author applied to a certain district. They are generally readable, and often contain valuable information, but they can hardly be looked upon as works of reference; the restricted area of their explorations, in nine cases out of ten, is a cause of weakness. Excellent as guide-books to the district, they in no way fulfil the objects the writers of the present work contemplate in bringing it out.

The Therapeutic Chapters, by Dr. Prosser James, have been penned after a practical knowledge obtained at the source of many of the most important waters. The analyses are from the waters supplied by export; and a chapter has been added upon Artificial Mineral Waters, as being a subject intimately connected with the Natural Springs.

The writer of this Preface must acknowledge his indebtedness to the following works:—Watt's "Dictionary of Chemistry," Dr. Candellé's "Manuel Pratique de Médecine Thermale," Dr. Madden's "Spas and their Uses," Dr. Oliver's "Mineral Waters of Harrogate," and numerous pamphlets.

C. R. C. T.

DUBLIN, *May*, 1883.

My contribution to this little volume consists of the Chapters on the Therapeutical action and uses of the several Mineral Waters. These are Chapters 2, 4, 6, 8, 10, 12, 14, and 16.

In writing them I have supplemented information acquired at the Spas by my experience of the use of the imported waters in London practice. In discussing the properties of the waters I have had before me Professor Tichborne's new analyses.

P. J.

3 DEAN STREET, PARK LANE,
May, 1883.

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THE

MINERAL WATERS OF EUROPE.

INTRODUCTORY.

So much has already been written on mineral waters and spas generally, that the following articles might seem superfluous. But there is good *raison d'être* from at least three or four points of view. The extraordinary commercial aspect which the importation of mineral waters has assumed within the last ten to twenty years, and the ever-recurring claims for the patronage of the profession for new importations, renders it necessary to discover how far the so-called genuine spa waters represent the original springs. Most of the analyses produced are those which have been issued by the proprietors of the springs, some of them very old and specially selected, and out of date. Now it is well understood that all spring waters are subject to change as regards their chemical composition, and this is much more marked in those waters which are heavily loaded with salts. The loss of carbonic acid gas in the bottled condition will also bring about great changes in the general composition. The natural change which sometimes takes place in the water at the fountain head is illustrated by the analyses of Hoffmann and Muspratt, in connection with the Harrogate waters, in which a marked alteration in a certain spring was evinced in a few years. Another reason for the re-examination of the most important of these mineral waters is the progress which the

whole subject of water analysis has undergone within recent years. The spectroscope has given us facilities for the qualitative estimation of rare elements not possessed by the chemists fifteen years ago. Thus the writer of the present article detected, for the first time, in 1868, by the aid of the spectroscope, considerable quantities of lithia in the Schwalheim waters, although these waters had been analysed by Liebig six years previously. Without advocating homœopathic doses, we must acknowledge that in a mineral water, particularly those that are drunk copiously, small doses may, and in many cases do, wonderfully modify the therapeutic action.

Another point in the analyses of mineral waters seems to have been practically ignored. Many of these waters, particularly sulphuretted waters, are sometimes merely the result of decomposition attending the decay of organic matter. The result may, therefore, be a water which outside those constituents which give rise to its dignity as a mineral water, resembles sewage in its general character and properties. The writer has examined such a water, and found it was with considerable difficulty that the barrier erected by faith could be broken through.

It must never be forgotten, however, in considering the composition of mineral waters, that as regards the arrangement of the elements by the chemist there is a great deal of theory. This is the chief reason that the more complicated spas cannot be imitated artificially. The chemist evaporates down a certain bulk of water, and we will say correctly estimates the relative amounts of acids and bases present, and then arranges them in his statement according to their known chemical affinities ; but so many changes have already taken place during the act of evaporation, that the arrangement he is authorised in mapping

out does not represent the true arrangement which previously existed in the natural waters, more particularly as the loss of the gaseous products have materially changed the structure of the fixed salts. This is one of the difficulties which is always felt in water analyses, and never more so than in the examination of some of the complicated spa waters. In an interesting little book (now quite out of date) published in 1856 by the late Prof. Aldridge, called a "First Trip to the German Spas," the author falls into this error in supposing that such waters can be made artificially with impunity. No more difficult problem is really presented to the practical chemist.

THE THERAPEUTICS OF MINERAL WATERS.

It should be clearly understood at the outset that the therapeutical observations in these pages are to be applied chiefly, if not entirely, to the bottled waters as found in the market. The several hygienic agencies which are brought to bear on the patient who visits the springs, and exercise no little influence on his health, are therefore to be omitted from our consideration, and we are to direct attention only to the action of the waters when taken in the same manner as other articles of our materia medica This can now be more satisfactorily done than heretofore in consequence of the new analyses here published. It is with these before us that the therapeutical notes are penned, and without discarding previous information, the indications afforded by considerable experience of the medicinal use of the waters will no doubt be modified by these new analyses, since they show us the composition of the waters at the time they are consumed.

CHAPTER I.

CHEMICAL CHARACTERS OF THE MINERAL WATERS, IN CLASSES.

THE classification of mineral waters is a subject that presents great difficulty, and has been treated in different ways. The alphabetical arrangement would perhaps get over all difficulties, but would hardly facilitate the inquiries of the medical man. Mineral waters often differ in their temperature when examined at their source. Thus we have all degrees, from the Malvern waters below the atmospheric temperature, to the boiling springs of Iceland—from the almost ice-cold waters of Silesia, to the hot Sprudel of Bohemia : attempts have been made to classify them from these degrees of temperature. Such a classification might amuse the crotchets of our ancestors ; whilst of little use even to those who use the waters locally, it is utterly worthless for the purposes of these articles.

Their general, or most marked chemical character appears to us to present the most feasible method of classifying mineral waters. One well known work proposes to classify them on this principle : but suggests the rather crude division of sulphurous, chalybeate, and saline. We propose as the main or primary classes five, namely : 1, saline or aperient ; 2, alkaline or antacid ; 3, ferruginous or chalybeate ; 4, sulphurous ; 5, potable or in different.

1. The *saline* or purgative waters mainly owe their medicinal virtues to the large quantities of magnesium, or sodium sulphate, as in the Hunyadi János, where these two salts occur in nearly equal proportions and in large quantities. When the magnesian sulphate and chloride occur in large proportions the waters generally are known on the Continent as bitter waters, as they owe their bitterness to the above-named salts.

In the Kreuznach water of Prussia we have a saline water of another class in which, according to the published analysis, we have about 900 grains of salines to the gallon, and which is absolutely free from the presence of alkaline or magnesian sulphates. We are not justified in dividing such waters from the other saline waters, because if we exclude any special action of the other ingredients they still remain purgative waters, and very frequently are generally associated chlorides and sulphates ; perhaps we might further classify the saline water as "haloid saline," sulphuric saline, or, when combined, as "sulphuric-haloid saline."

2. The *alkaline* waters generally owe their alkalinity to the carbonates or bi-carbonates of the alkaline earths conjointly with the potassic or sodic carbonates. The antacid properties are, of course, more marked with those waters which contain a sensible quantity of the alkaline carbonates, chiefly sodic and potassic bicarbonates ; whilst the lithium, and other alkaline earths, are specially indicated in urinary diseases.

The term "alkaline acidulated springs" is sometimes used in connection with these waters. We confess we hardly understand the term or the sense in which it is used, because, in many lists, it seems to be applied indefinitely, and just according to the *caprice* of the writer.

We find in waters similarly constructed, some are so named, whilst others are not. Almost all these waters, from a geological necessity, must contain free carbonic acid gas, and, in a sense, are acidulated; but the loss of the excess of that gas must result, probably, in an alkaline condition, but certainly in a neutral liquid.

3. *Ferruginous or chalybeate* waters contain the iron, in three conditions, either as a ferrous or protocarbonate of iron, or as a basic or neutral sulphate. It is generally present in either of the two first conditions, and although the protocarbonate is considered the most useful and valuable form, (it is certainly the one most pleasant to take), it is not so permanent a water for bottling.

4. *Sulphurated.*—The iron in chalybeate or ferruginous waters is frequently the result, or at least is associated with the decomposition of organic matter; and this remark also applies to the next class, which are called sulphurous waters (better sulphurated waters). It has been the custom in days gone by (the dark days of science) to value a water which smells like rotten eggs according to the vileness of that smell. Now, it is self-evident that although its odour may in a degree be a measure of the quantity or presence of sulphur, if that sulphur is produced from the reduction of mineralised sulphates by the decomposition of organic bodies, we must also take it as evidence of a very large proportion of matter in a most objectionable form. Sewage often smells strongly of sulphurated hydrogen, and we are bound to say, that unfortunately many of the so-called sulphur springs owe their sulphuretted hydrogen and alkaline sulphides to precisely the same cause. Such a water is simply poisonous, and the prolonged use of it must end in lamentable results. Fortunately Wanklyn's albuminoid

ammonia process presents an easy and certain mode of determining this point. But the process when applied to sulphuretted waters requires a little modification. In an ordinary water it is usual to distil off the *free* ammonia from a given quantity of water, and to estimate this free ammonia by Nessler's test ; the residual water is then distilled with an alkaline solution of permanganate of potassium which has previously been purified from ammonia. Any ammonia now found in this second distillate must proceed from the oxidisation of nitrogenous organic matter, the nitrogen in such a case coming off in the form of ammonia. But as the sulphuretted hydrogen would and does interfere with the reaction of the Nessler, we distil off in a flask the free ammonia, adding after the process has continued a short time, a few drops of a pure solution of peroxide of hydrogen. The free ammonia is thus lost, but is of no consequence to our experiment. In such waters free ammonia in reasonable quantities may be neglected.

Any remaining products of sulphur are oxidised by the second part of the process into the perfectly stable sulphuric acid which no longer interferes with the reaction of Nessler's reagent. We generally add a given quantity of the water under examination when deprived of its free ammonia, and sulphuretted hydrogen to the action of a considerable excess of caustic soda (from sodium) and permanganate of potassium for some time in the cold ; and then distil and tritrate in the usual manner. Any ammonia now found in the distillate must proceed from nitrogenous organic matter present in the water, providing the chemicals employed are absolutely pure.

The term usually applied to these waters is sulphurous. Now although used in medical and other works, and by the profession generally, it is evidently a term so mis-

applied that we shall confine ourselves in future to the term sulphurated. "Sulphurous" from every chemical analogy would convey the idea that the sulphur in these waters was present as sulphurous acid, or as the class of salts known as sulphites ($M''SO$)—whilst it really exists as sulphides (MS). These sulphides in the presence of water, or in their hydrated state give rise to the fœtid odour which is their chief characteristic. There are many modes in which we may suppose that these sulphides are produced geologically, for instance, the direct combination by igneous action of calcium rocks with sulphur, or sulphides, and the subsequent decomposition of the calcium sulphide by carbonate of sodium. Such a decomposition would be effected in the moist way if under pressure. The sulphur when in the assimilable form exists as sulphydrates of the alkalies and alkaline earths, which are easily decomposed, and give rise in such water to a fairly permanent smell of sulphuretted hydrogen—

$2\,NaHS$	$=$	Na_2S	$+$	H_2S
Sulphydrate of sodium.		Sulphide of sodium.		Sulphydric acid.

On boiling such a solution this decomposition is much more marked, and we ultimately get a perfect decomposition, so—

Na_2S	$+$	H_2O	$=$	$2\,NaHO$	$+$	H_2S
Sulphide of sodium.		Water.		Hydrate of soda.		Sulphuretted hydrogen.

The writer has in his previous researches proved that all salts in the mere act of solution are to a certain extent dissociated, and this fact is the cause of all soluble sulphides when in solution giving off sulphuretted hydro-

gen, or their acidulous radical. As this becomes oxidised into the higher or prolythionic acid—combines it with the base and fresh proportions of sulphuretted hydrogen are set free as long as any sulphides are present. It is generally stated that when the sulphydric acid is chiefly combined with calcium it gives a more permanent sulphuretted water, then when present as a sulphide of sodium; *cæteris paribus*, we doubt if this is strictly correct. The sulphydrate of calcium will give a more strongly smelling water by virtue of its more ready decomposibility.

We frequently find that sulphuretted waters of a true mineral origin have associated with their bases barium and calcium. This is the case in the Harrogate sulphuretted waters—one of the best waters of its class.

In fact it has been too much the fashion to run down the Home waters, and the Continental medical men are only too glad to make little of that which the professional men of this country seem to depreciate. This undesirable state of things has been induced, no doubt, by the very proper value which the medical man attaches to climatic influences and change of scene—items which should not, for a moment, be considered unimportant—but now that the bottling of mineral waters has become such a special trade, we see no just cause why English waters should not compete in this direction. The names of many foreign, but inferior waters, are well known in this country, and largely run after.

Candellé, in his useful *Manuel Pratique de Médecine Thermale*, 1879, disposes of the English waters in about six lines. He says, *L'Angleterre est un des pays les plus pauvres en sources médicinales.* It will be part of our programme to dispell this illusion. His book is instructive as showing that even in the present day faith forms a

very important factor in *Médecine Thermale,* as practised on the Continent.

5. *Potable Waters.*—We have now to notice waters which are often spoken of in medical works as unimportant, that is, of indifferent waters, or waters in which the therapeutic action is not sufficiently pronounced to be used in the direct treatment of disease. Some of these waters may contain infinitesimal quantities of ingredients, which by their constant use might produce remedial effects ; but it is their use as potable waters, or for table drinking, that from our view renders this section of mineral waters most important. The great increase in the use of mineral waters in everyday life is desirable, providing we can insure that the water is perfectly free from organic impurities, and providing that the mineral matters are sufficiently definite in character.

The mineral salts in a table water should not, as a rule, much exceed 1,000 grains per gallon. When it exceeds this quantity it should not be indulged in too freely. All waters should be used judiciously, according to the idiosyncracy of the consumer, and the peculiarities of the water. The medical man is the proper person to determine this point : another of the many reasons that the mineral water question should be put definitely before the profession.

The remarks made in connection with the presence of nitrogenous organic matter in sulphurated waters and chalybeate waters, apply with double force in the case of these potable waters—waters which are drunk freely and constantly—and it is absolutely necessary that a water which becomes an inmate of our house should be like Cæsar's wife, beyond suspicion. In the days of Liebig, and even in the early analyses of Fresenius, these point

were not sufficiently investigated, and it is our intention to re-investigate analyses of that period. In some waters we find that very full and careful analyses have lately been done by men of acknowledged celebrity. In such cases we will give the most recent and careful analyses, stating at the same time our authority.

Directly we accept the desirability of using a mineral water in its potable sense, we must at once consider it simply as a food product, and, therefore, the nearer it resembles the mineral constitutents of the blood the more generally it may be relied upon.

In a previous paragraph we cursorily referred to the composition of the blood by stating that if mineral waters were used constantly at the table their constituents should bear a certain relation to the ash of the blood. This fact has been made use of on more than one occasion amongst the numerous puffs and advertisements put forward by the proprietors of mineral waters, and although like every other theory or proposition of this kind, it is frequently carried to an absurd extent, an abnormal amount, or any abnormal ingredient would be no recommendation to the extensive use of a water for table purposes. Owing to the laws of exosmosis and endosmosis the salts in the blood never undergo any more than a very temporary change in mineral composition, but we can readily perceive that where a copious and constant inroad of fluids highly charged with easily diffusible salts takes place into the stomach—from physical laws alone a certain and unnecessary strain is put upon the animal economy, which must be objectionable. Chloride of sodium and the alkaline chlorides are the most diffusible of all salts, and therefore, from this reason may be considered in reasonable quantities not to be injurious. The alkaline

sulphates are not so diffusible, and this probably will account for their more energetic purgative properties.

In the writers' opinion the chlorides of the alkaline earths should never amount to anything very considerable. In excessive quantities some writers on therapeutics are of opinion that these salts interfere with the digestive functions, but on chemical grounds alone we are dealing with bases which, presented in their more soluble condition, have a tendency to form more insoluble compounds, which may give rise to difficulties in the emunctory organs if used in a superabundant quantity over that necessary for bone deposition. The physicians may, however, see cases where such a condition might be desirable. In reference to the analogy desirable between waters for drinking purposes, and blood, we will briefly detail the composition of the fluid. According to Schmidt, 1,000 parts of man's blood contains 513 parts of moist corpuscles, and 486·98 of serum, both rich in salts. The mineral matter of the corpuscles amounts to 81·2 per cent., whilst that of the serum is 85·5 per cent. The potassium salts seem to accumulate in the first, whilst in the serum the potassium and sodium salts seem about equally divided. According to the latest researches of A. Jarisch, 1877, the following are the normal mineral constituents of blood. The acidulous radicals are as follows :—

Phosphoric ($P_2 O_5$) . .	8·61
Sulphuric (SO_3) . . .	11·44
Chlorine (Cl.) . . .	28·63

The writer will add to this list fluorine, which he believes is always present, and must be considered a

normal constituent, just as it is of bone. The bases are :—

Sodium (Na_2 O) . . .	26·06
Potash (K_2 O)	22·92
Lime (Ca O)	1·24
Magnesia (Mg O) . . .	0·52
Ferric Oxide (Fe_2 O_3) . .	7·03

Lead and copper have been stated as being present in the blood, but they are simply accidental ingredients just as lithium which appears in the blood after a course of lithia water.

We now come to waters, which are special in their action from containing special ingredients in sufficient quantities to produce marked reactions.

Arsenious acid is one of the ingredients which gives any special therapeutic qualities to mineral waters, more particularly as the dose is small. The mineral waters containing arsenic are, as a rule, even more energetic than a granular dose of arsenious acid *per se* would be. Some of these arsenical waters are said to contain 28 mm. per litre. Lithium has been found in an immense number of the alkaline waters, which previous to the introduction of the spectroscope had not been found to give any reactions indicating the presence of that metal. We do not, however, mean by lithia waters such waters as these. Some of the lithia waters contain six to eight grains per pint, and exert very marked chemical reaction. Bromine and sodium are frequently found in mineral waters in considerable quantity.

CHAPTER II.

THERAPEUTICS OF THE CLASSES OF MINERAL WATERS MENTIONED IN THE LAST CHAPTER.

It is considered desirable to append a few remarks on the remedial uses of mineral waters in classes before proceeding to treat of individual springs. In so doing we shall follow the order adopted in the chemical division of this work. Inasmuch, however, as the imbibition of more or less liquid exercises no slight influence on the body, we are met by the preliminary consideration of the internal use of pure water. An adult will in health take an average quantity of nearly four pints of fluid a day; some thirsty souls take much more and some do with less. A few make simple water their chief fluid; others consume much milk; a larger number take a considerable proportion of tea, coffee, cocoa, or other simple beverage; too many almost exclude the simpler fluids by the amount of alcoholic liquors in which they indulge. In this last case, of course, the effect of the alcohol masks that of the fluid, but we must not forget that the amount of liquid drunk and the time at which it is taken exercise some influence. Of course, the amount of liquid received has to be counterbalanced by that removed, so that the skin, lungs, and kidneys are called upon to get rid of the average four or five pounds of water a day, and of any excess that may be injested. As the water is taken into the system and is the vehicle for the removal of waste it may be regarded as in

some sense washing the tissues. It is commonly said that very little water passes directly through the pylorus into the intestines, but Küss is of a different opinion, and the writer of this chapter endorses his view—more especially when large quantities are taken.

But the water thus required to maintain the balance of the system is only a small part of that which is always at work in the economy. The quantity daily poured with the secretions into the alimentary canal, and again re-absorbed by the lymphatics and termini of the vena portæ, is variously estimated at 12 to 24 pounds. This water is the purveyor of various solids which are precipitated and left behind, and the solutions in question must contribute their share to the manufacture of the chyle. Water freely passes from the stomach into the vena portæ; thence it goes through the liver, where it becomes charged with the products of that organ, and brings them again into the intestines where they are precipitated. Hence we may understand the repute of free water-drinking as a cholagogue, and as powerfully assisting the abdominal circulation. Apart then from its mechanical effect in the primæ viæ, which varies with the quantity imbibed at a time, water may be regarded as the great diluent, solvent, and eliminant. It dilutes the contents of the stomach and intestines, and thus acts as an aperient. It also dilutes the whole mass of the circulating fluids; but probably the blood is only influenced thus for a brief period, its specific gravity being maintained with tolerable uniformity. We have seen how it dilutes the bile and thus acts as a cholagogue. In the same way it is a diuretic and diaphoretic by dilution of the excretions of the kidney and skin, and the same may be said of its effect on all secretions. Add to its diluent its solvent powers, and we see why it is the

most valuable eliminant: dissolving various substances and increasing all the secretions by which they are removed it increases tissue changes, and thus loss of body-weight would ensue unless counteracted by the fresh arrival of aliment. It may thus increase appetite, and prove the best tonic; but if appetite fail, or food cannot be obtained, it would hasten wasting. By removing waste tissues it is believed that it may thus affect morbid deposits, though this power is more frequently attributed to medicinal waters.

The temperature at which water is drunk has a great influence. Absorption appears to take place at about the temperature of the blood, and to secure rapid removal from the stomach by absorption it should be taken at about that point, and in small quantities at a time. Cold water in small quantities stimulates the stomach and assists digestion. A full draught is apt to impede that function—in weakly people "lies heavy" for a long time, and the danger of drinking very large quantities when the body is hot and exhausted, is well known. A glass of cold water early in the morning is an excellent aperient, stimulating the peristaltic action by its temperature, and promoting the secretions in the way already described; a draught rich in carbonic acid is still more effectual. Cold water may be given even when the temperature is high, and it does not give rise to discomfort. On the other hand warm water is more grateful in many painful affections of the abdominal organs; it is better to increase the action of the skin, to promote other secretions, and possibly to stimulate the absorption of morbid deposits; as a cholagogue it is often efficient if taken regularly at bed time, or night and morning. In laryngitis and bronchitis the use of hot drinks is well known as a popular remedy. Warm beverages are also popularly regarded as more refreshing than

cold. Excess in drinking liquids either warm or cold gives rise to certain complaints well-known to medical men, but as this work is intended to be restricted to the bottled waters, it seems unnecessary to describe the evils that are sometimes produced at certain springs.

We have next to consider the action of mineral waters. The effect of a glass of water containing a fixed amount of solid or gaseous substances might be supposed to be the same as a similar dose of the active ingredients. Usually more fluid is taken than in pharmaceutical preparations ; hence we have to do with the effect of the water as well as the medicine ; and with the variation induced in the latter by dilution. The former we have seen depends on the quantity drunk, the time at which it is taken, and its temperature. With regard to the latter, the effect of solids is perhaps better understood than that of gases. Some mineral waters are charged with large quantities of solids, for example, some of the stronger, bitter, saline, purging waters ; others contain an almost inappreciable quantity of mineral ingredients. These solids are absorbed with the water, and produce their usual medicinal effects, but it is to be remembered that dilution tends, as a rule, to increase that action. Thus a small dose of sulphate of magnesia or soda in a large quantity of water will prove as active a purgative as a large dose less diluted. Then, again, the frequency of repetition in many cases is an important question, for on this depends whether the ingredient be circulating in the system almost constantly, or only for a brief period. This depends in its turn on the rate of elimination and the frequency of the dose, a point which, in reference to mineral waters, has not been sufficiently attended to. The effect of the gases is less understood. Carbonic acid is an agreeable stimulant to the stomach,

from which, however, most of it is speedily eructated, but some of it passes into the intestines and stimulates peristalsis. So marked is this effect that carbonated waters are advantageously substituted for salines in many cases in which the latter are still frequently prescribed. Constipation from torpor of the bowels is not amenable to the more irritating laxatives of saline waters, but may often be overcome by more simple remedies, such as the popular glass of cold water, fasting; or the still more appropriate use of a highly carbonated, but not purgative, mineral water. Further, the carbonic acid gas has the power of holding other ingredients in solution, and making the dose more palatable. Of the effects of nitrogen, sometimes vaunted as an ingredient, nothing positive is known. Minute quantities of sulphuretted hydrogen are supposed to have a value as pronounced as the flavour of the water which contains this gas. Of other gases nothing need be said here.

Coming, then, to the effects of the individual classes, we may briefly sum up their commonly reputed remedial value prior to a fresh investigation of their merits.

1. *Salines.*—The so-called bitter or purging waters owe their aperient qualities to sulphate of magnesia and soda, the effects of which as medicines need not be described. In small repeated doses they can be made to induce an artificial diarrhœa; in large ones they are more or less cathartic. The more freely diluted the more active they usually are, and in this class of waters, therefore, we have highly diluted saline laxatives, modified in their action by the other ingredients and the temperature at which they are taken. These waters are highly prized as occasional or habitual aperients, and are regarded as specially useful in congestion of the portal system, and in the condition

termed plethora. Püllna water is rich in both sulphates ; Friedrichshall contains less, but has in addition a good deal of sodium chloride. Cheltenham is much weaker. We have also saline waters in which magnesium sulphate is absent, or nearly so, as in Leamington. In some of these we find carbonate of soda present, as in the highly prized waters of Carlsbad. Next come waters in which sodium chloride is the sole or chief ingredient. Some of the most celebrated springs, as Kreutznach, Wiesbaden, Baden, Homburg, belong to this division. The action of these waters is solvent and alterative. The salt in the blood is temporarily increased ; it rapidly passes into the several secretions. Tissue metamorphosis is increased, the bowels rendered more active, and the kidneys notably stimulated. Absorption is thus promoted, but the belief in disappearance of tumours under its influence is mostly confined to the neighbourhood of the Spas, where these wonders are related. In gout some of these salt waters are very useful. In anæmia, hepatic disorders, and uterine maladies they are also in repute. In scrofula and chronic rheumatism those springs which also contain iodides and bromides are indicated.

2. *Alkaline Waters.*—In this class we have the direct and the remote alkaline effect to consider. Their antacid value as soon as they enter the stomach will be in proportion to the alkali contained. In Vichy, the type of these waters, we possess a powerful remedy containing a considerable quantity of sodium carbonate. As soon as it is absorbed it will increase the alkalinity of the blood, and its effect is soon seen in diminishing the acidity of the urine, which fluid it may neutralise, and even render alkaline, if unduly pushed. This class of waters may therefore be employed in acidity of the primæ viæ, in chronic

cutaneous affections, in some bronchial and pulmonary diseases, in calculi, diabetes, Bright's disease, gout and rheumatism, glandular enlargements, and functional uterine disorders. The indications are indeed too various to be discussed in a paragraph. Besides Vichy, already mentioned, Bilin and Vals are powerfully alkaline. Ems and Royat are much weaker. Mont Dore and Wildungen contain comparatively little soda, but the former boasts its small quantity of arsenic ; the latter its iron.

3. *Chalybeate Waters.*—The medical use of iron is so everyday an occurrence that no wonder waters known to contain the metal should be popular. There is little doubt that iron may be assimilated, if taken in these waters, in cases in which it is scarcely tolerated in the most refined pharmaceutical productions. When it occurs as carbonate it is most palatable, and often most effectual. Iron is often present in other classes of water affording useful combinations. Spa is the most popular spring of the kind, and very accessible. Schwalbach contains much gas, and is therefore good for bottling. Tunbridge has but little gas, but deserves its popularity as a simple chalybeate.

4. *Sulphurated Waters.*—From what has been stated in the chemical division of this work, readers will be prepared to doubt whether the repute of these waters ought to be attributed so much to their sulphur compounds, and from the remarks made on waters in general, the other influences may obtain more notice than usual. Many of the most famous sulphurated waters are little else than indifferent ones with a flavour of sulphuretted hydrogen. Eaux-Bonnes and other Pyrenean springs, as well as Aix-les-Bains, may be thus described. It may be stated, however, that lately some writers have assigned remarkable herapeutic properties to sulphides in minute doses. Such

statements must be received with caution, and certainly are incapable of accounting for the clinical records of the chief sulphurous spas. Some of these are in repute for respiratory diseases, as Eaux-Bonnes. In digestive disorders Eaux Chaudes is regarded as more suitable, while Luchon is celebrated for skin affections ; and at Aix-la-Chapelle the claim is asserted for removal of poisons from the system, whether syphilitic or metallic. No doubt all these waters stimulate the kidneys and skin. They are usually supposed to quicken the circulation, though some attribute to them an opposite effect. Whether in the diuresis induced the quantity of urea excreted is increased, is still in question. The bowels act more freely under their use, the dejections sometimes becoming blackened. Enlarged glands are reduced. Anæmia may follow prolonged use. These waters are most used in chronic rheumatism, in scrofula, in diseases of joints, and in numerous skin diseases. They are employed in some chronic respiratory diseases, in functional uterine disorders, and to eliminate mercury, syphilis, &c., from the system. Some of the most popular springs have been named ; to these should be added Harrogate, which, although English, is one of the most powerful, and situated in a fine bracing country, to which a visit might often be more restorative than a Continental trip, if less fashionable.

5. *Table Waters.*—Waters containing a minimum of solids, some of them much less than ordinary potable water, are usually called *indifferent.* As certain qualities are claimed for them it would be better to call them *table* waters, for this is their chief use in bottle, though many are largely used at their springs for bathing, especially the thermal ones. In the bottled waters the presence of carbonic acid would seem to be the chief point, for this gas

renders them palatable, and we have seen that it may stimulate digestion. The marvellous qualities attributed to some of the ingredients met with in minute quantities—mere traces—serve to amuse the credulous; and sometimes the presence of these substances induces people to replace injurious fluids by these innocent waters. Those waters which contain a little lime and magnesia are sometimes distinguished as earthy waters. Some are more related to saline, as they have enough sodium carbonate and chloride, to give them character. Others contain traces of iron, lithium, or other minerals. It is, however, chiefly as pure water, usually agreeably aërated, that we must regard them; and the effects of drinking water and of carbonated water have already been considered. Buxton and Bath represent these waters in our own country. The water of the latter has lately been successfully aërated. Malvern, and numerous "holy wells" that have lost their popularity, also furnish excellent table waters. France sends us the favourite St. Galmier, and Germany numerous specimens.

CHAPTER III.

CHEMISTRY OF THE PURGATIVE WATERS.

Friedrichshall.—Friedrichshall Saline Springs lie a little to the South of Heidelberg, on the road to Heilbronn, and situated in a district abounding in salt works and springs. This water is an old friend deservedly held in high estimation. The proprietors publish valuable testimonials from Liebig, Sir Henry Thompson, and others, but except in very special cases, it is not our intention to quote from the numerous puffs published with mineral waters, but simply to relate our own personal experience and to confine ourselves as far as possible thereunto. It is curious to observe that this well-known water, when examined in the bottled condition, gives very different results from the published analysis. If we were seeking for an illustrative example of the necessity of a thorough examination of mineral waters, we could not have hit upon a better one. We do not mean to say for a moment that there is anything wrong about this water as bottled. It agrees in almost every respect with the analysis published by the proprietors as regards the quality of the ingredients, and also very fairly as regards the relative proportions; but here the analogy ends, and we find the Friedrichshall water of commerce much stronger and centesmally richer in ingredients than the published analysis. This might at first sight seem unimportant, but when we find Sir Henry Thompson basing his remarks

upon the relative amount of grains of sulphate of soda and magnesia contained in a pound of this and other water to such a nicety that 30 grains of a salt determines the relative merits of two waters, it becomes a very striking discrepancy. His remarks are as follows :—

The most powerful of this group is that of Pullna, which contains 154 grains, or nearly 2½ drachms, of sulphate of soda to the English pint, and nearly 2 drachms of sulphate of magnesia. Those quantities would give a tolerably efficient purge to anybody. But you must not give a pint of Pullna ; five ounces would be a full dose. I do not like Pullna generally for our purpose, because it purges too freely, often gripes, and is very nauseous. Half a drachm of sulphate of soda and half a drachm of sulphate of magnesia in this form is too much for many people. I therefore recommend Friedrichshall, which contains not a drachm of sulphate of soda in a pint, and little more than three-quarters of a drachm of sulphate of magnesia. Nevertheless, you would not think of giving a pint ; eight or nine ounces make an efficient purge ; for many persons six or seven suffice. I think I may say that seven ounces is an ordinary average dose. If you take seven ounces of Friedrichshall water an hour before breakfast, and soon after a cup of hot tea or coffee, you will have a full, free action of the bowels ; perhaps two. That, you see, would be about twenty-five grains of sulphate of soda and twenty grains of sulphate of magnesia, which, taken in any combination you like out of a druggist's drawer, would have no appreciable action ; you might be a little uncomfortable, perhaps, but there would be no action of the bowels. — (Sir Henry Thompson's Lecture on the Early History of Calculous Diseases.)

How can we make this to agree with the fact that we find the Friedrichshall water contains ⅓ more salts than given in Liebig's original analysis ? The imperial pint being 4 ounces more than the fluid pound, as given in

Liebig's, would give respectively 57½ and 47 grains of sulphate of soda and sulphate of magnesia, or, as Sir H. Thompson says, nearly a drachm of sulphate of soda, and ¾ of the magnesium purgative.

The above remarks are evidently based upon the old analysis of Liebig, which we now give.

Analysis by Liebig, grains per pound or 16 *ounces fluid.*

	Grains.	Grains per pint.
Sulphate of soda	46·51	... 57½
Sulphate of Magnesia ...	39·55	... 47
Chloride of sodium ...	61·10	
Bromide of magnesia ...	0·37	
Chloride of magnesia ...	30·25	
Sulphate of Lime	10·34	
Sulphate of potash	1·52	
Carbonate of lime	0·11	
Carbonate of magnesia ...	1·16	
Silica	0·33	
	191·24	
Carbonic acid	5·32 cubic inches	

Therefore, the total amount of solids in an imperial gallon of 10 pounds would be 1,912·4 grains.

The following figures represent the result of our own analysis in grains per gallon :—

Sulphate of soda	715·35
Sulphate of magnesia ..	641·38
Chloride of sodium ...	997·22
Bromide of magnesia ...	2·75
Chloride of magnesia ...	501·14
Sulphate of potash ...	25·18
Sulphate of Lime	171·30
Carbonate of magnesia with traces of lime	21·02
Silica	4·40
Total solids per gallon	3079·74
Carbonic acid not determined	

Skeleton Analysis of 10 *Fluid Ounces, or Half-a-pint.*

Total Solids.	Purgatives.	Salts, &c.	Antacids.
192·4	84·7	95·3	1·3

It is stated that Friedrichshall water keeps well in the bottled condition, and a glance at its composition will show that this fact is very probable. A temperature of 50° to 60° Fah. is stated to be the proper temperature of this water.

In concluding our remarks upon Friedrichshall water, we may state that, although strictly a purgative one, it contains just a sufficient quantity of magnesian carbonate to render it permanently alkaline, and it can hardly be classed as an aperient *alkaline* water. It is not alkaline to phenol-phthalein in the cold, but becomes permanently so on heating—its aperient character is the most marked. This water is remarkably free from organic impurities.

Pullna Water.—This water is one of the oldest and best known of the purgative waters. It is almost exclusively consumed, we believe, in the bottled form, and, owing to its freedom from the carbonates of the alkaline earths, keeps well in that state. Pullna water must fluctuate very much as regards its composition, if we are to credit the numerous analyses which have been published from time to time. Owing to it being a very well-known water, there are many extant. The total solids per imperial gallon are, according to different authorities, as follows :—

Barruel (Advertisement of Proprietor) (*a*) ...	4340	grains.
Struve	2483	„
Watt's "Dictionary of Chemistry" ...	2293	„
Ficinus	2229	„

(*a*) "According to the minute analysis of Barruel, the Pullna Water contains, in 1 litre of water, the enormous quantity of 62 grammes of salts.'

The Pullna Water examined by us did not contain 2,000 grains per gallon when thoroughly dried at a steam heat.

It will be observed that the points in which the following analysis differs from Struve's is the absence from his analysis of the nitrates and organic matter, points of considerable importance. His figures are those generally quoted in works upon mineral waters. Struve does not mention lithia as being present, and so far agrees with our examination; but traces of that substance might occur from the earthen vessels in which this water is imported, or from some other accidental cause.

It is stated in the Pullna advertisements that this water contains lithium; if so, it must be in very minute quantities, as we failed to detect it even with the spectroscope. The composition is—

Sulphate of magnesium	663·52
Sulphate of sodium	881·53
Sulphate of potassium	35·10
Sulphate of calcium	19·26
Chloride of magnesium	126·13
Carbonate of magnesium	54·80
Carbonate of calcium	6·20
Phosphate of calcium	0·04
Silica	2·03
Organic matter (not determined) ...	0·00
Containing free ammonia ·002 grains	
„ albuminoid „ ·003 „	
Nitrates—trace	0·0
Total solids per gallon ...	... 1788·61 grs.

Carbonic acid gas, not determined.

The presence of the organic matter and nitric acid is, however, of much more importance. We do not admire Pullna Water, in spite of its wide fame, and we may congratulate the drinkers thereof, that owing to its strong pur-

gative properties, its dose is comparatively small. It has all the character of a water impregnated with surface drainage, not perhaps to an extent to render it unhealthy, but certainly substances which in a potable water would be considered out of place are found in this mineral water. Skeleton analysis of the half-pint (10 oz.).—

Total Solids	Purgatives	Salines	Antacids
112 grs. ...	104½ ...	35 ...	3·8

This water is neutral in its reaction to phenol phthalein but becomes perfectly alkaline on heating, owing to decomposition induced in the magnesian salts.

Rákóczy Buda (Ofen).—Rákóczy is one of the most concentrated bitter purgative waters we have — magnesium and sodium sulphates being the most marked ingredients, yet this water presents some striking peculiarities. It contains a very considerable quantity of lithia. When examined with phenol-phthalein it presents no alkaline reaction, but on warming, becomes permanently alkaline. It is also slightly chalybeate. It contains—

Sulphate of magnesium	...	1752·59
Sulphate of sodium ...	...	1457·96
Sulphate of calcium ...	...	467·32
Sulphate of lithium ...	...	10·49
Sulphate of potassium	...	4·69
Sulphate of ammonium	...	4·92
Carbonate of sodium ...	...	30·38
Carbonate of calcium ...	...	49·00
Carbonate of iron ...	...	3·77
Silica	...	3·61
Alumina	...	1·89
Chloride of sodium ...	...	161·98
Bromine	...	0·51
Fluorine, trace		
Total per gallon	...	3949·11 grain

Skeleton Analysis of contents of Half-a-pint (10 *ounces*).

Solids.	Purgatives.	Antacids.	Salines.
246 grains	200 grains	5· grains	$10\frac{1}{4}$ grains

The fluorine and ammonia were first noticed by the writer; the latter is present in small quantities, and as this water gives no further ammonia on distillation with permanganate of potassium, it shows that it is perfectly free from nitrogenous organic matter.

It is stated that Rákóczy is the most concentrated of all the purgative waters, and we have, so far, not met with one containing the same quantity of sodium and magnesium sulphates. How far this is desirable will, in a great measure, depend upon the case to which the water is applied, and must be determined by the physician. A peculiarity about this water (Rákóczy) is, that it is not only alkaline, but contains rather a considerable percentage of lithia, which might make it an invaluable water in special cases.

Hunyadi Jànos.—Another spring now well-known, and probably more patronised of late years in this country than any other purgative water, comes also from the Buda district, and is somewhat similar in character to the previous water, although not quite so concentrated. It contains :—

Sulphate of sodium	1579·57
Sulphate of magnesium	1563·50
Sulphate of potassium	7·16
Chloride of sodium	105·31
Carbonate of calcium	60·51
Carbonate of sodium	51·52
Carbonate of strontium	2·00
Silica	0·80
Oxide of iron ... ... } Alumina ... ... }	0·29
Free ammonia, trace	
	3370·66

Free carbonic acid not determined.

This, like the previous water, is a highly concentrated one, containing a great preponderance of sodium and magnesium sulphates. It was examined for lithia, but that substance was not present.

Skeleton Analysis of Half-a-pint (or 10 ounces) fluid grains:—

Solids.	Purgatives.	Salines.	Antacids.
210½ grs.	196½ grs.	6½ grs.	7 grs.

We have heard it stated that Hunyadi Jànos is an artificial product. It is just possible that this and the previous waters, from some idea that very strong purgatives are desirable, may have been strengthened, but, if so, it could only refer to the sulphate of magnesia and soda, as the great preponderance of these two salts lend countenance to such a view; but even if such were the case, the waters carry with them undoubted evidence of being originally genuine waters. Phenol-phthalein shows no alkalinity when added to Hunyadi Jànos but it becomes permanently alkaline on heating.

Marienbad Waters.

In all the previous purgative waters which we have described, their activity might be said to be due equally to the magnesium and sodium salts. The honors were equally divided between Epsom and Glaubers' salts. But in the waters we are now about to consider we shall demonstrate that the activity rests chiefly upon one ingredient. Such distinctions are well worth the careful consideration of our medical readers, and are points which hitherto have not received the nice discrimination which should be made in the use of mineral springs.

The Marienbad and Carlsbad waters are of this class and contain little or no sulphate of magnesium (some analyses give none).

The former, although comparatively new, seem to rival their more ancient friends at Carlsbad. They are situated about twenty-five miles from Carlsbad, and belong to the interesting Abbey of Tepl. Owing mainly to the springs and their romantic situation, Marienbad has grown into an important town. The waters are Ambrosiusbrunnen, Waldquelle, Kreuzbrunnen, and Ferdinandsbrunnen. We only give the analyses of the two last as they are those which are most frequently imported in the bottled form. The other two are not used as aperients. All the Marienbad waters contain traces of lithia and strontia, and are slightly chalybeate.

Ferdinandsbrunnen.

Sulphate of sodium	349·96
Bicarbonate of sodium	141·44
Carbonate of lithium	0·63
Carbonate of calcium	75·49
Carbonate of magnesium ...	69·53
Carbonate of iron	3·87
Carbonate of manganese ...	5·70
Carbonate of strontium ...	0·08
Chloride of sodium	13·12
Sulphate of potassium	5·27
Phosphates of alumina, &c. ...	0·31
Silica	7·53
Total	672·93

Carbonic acid gas not determined.

Skeleton analysis of half-a-pint (10 *ounces fluid*) :—

Solids.	Purgatives.	Antacids.	Salines.
42 grains.	22 grains.	18½ grains.	1 grain.

This water gives no colouration with phenol phthalein in the cold, but becomes very faintly alkaline on heating.

The Kreuzbrunner water hardly gives any indication of alkalinity with phenol-phthalein, even after prolonged boiling, and the slight alkaline condition induced thereby disappears on the water regaining its normal temperature; therefore, we may say that the water is almost practically a neutral water, it is not acted upon by treopeoline.

Kreuzbrunnen.

Sulphate of sodium	320·86
Bicarbonate of sodium	114·30
Carbonate of lithium	0·88
Carbonate of calcium	30·20
Carbonate of magnesium ...	20·60
Carbonate of iron	1·38
Carbonate of manganese ...	0·30
Carbonate of strontium, trace ...	
Chloride of sodium	101·59
Sulphate of potassium	2·44
Phosphate of aluminium and iron	0·57
Silica	4·05
Total solids	598·17

Skeleton Analysis of 10 *ounces fluid,* $\frac{1}{2}$ *an imperial pint.*

Solids.	Purgatives.	Antacids.	Salines.
37 grains.	20 grains.	$14\frac{1}{4}$ grains.	$6\frac{1}{2}$ grains.

Carlsbad.

The curious geological district of Carlsbad is situated in a valley in which the springs rise in all directions. Out of Iceland there are few specimens of hot water

springs that can rival this curious phenomenon. Baedeker describes the Carlsbad springs as rising near the Tepel from beneath a very hard kind of rock, known as Sprudelschale or Sprudeldecke, and that wherever this crust or stone is broken through, boiling water and steam rush up with great violence. The greater part of the town is built upon this crust, under which, it is believed, that there exists a vast lake of boiling and seething water. This imaginary reservoir is called the Sprudelkessel (spring cauldron). The steam escapes through artificial apertures made in the rock, and these apertures require to be constantly cleaned out on account of the incrustation or rapid deposition (we presume) of carbonate of lime. If, says Baedeker, one of the orifices are closed, the steam and water rise with augmented force at the other orifices, and have even been known to force a new passage for themselves to the imminent danger of the dwellers above.

Some of the statements about this cauldron of boiling water are extraordinary and perfectly startling. Thus it is said that at the earthquake at Lisbon the Sprudel ceased to flow for three days. The two places are a long distance apart, and it was probably merely a coincidence. It is stated that all attempts to fathom the depths of this abyss have failed, and yet that the crust between it and the town is nowhere more than three feet, and in some places appearing to be only as many inches. We confess we should not like to reside at Carlsbad. Few waters have been more frequently analysed or much more written about than the Carlsbad Springs, yet, strange to say, the presence of lithia up to this time has escaped observation. We find that it is present in all the springs; at least, we have discovered it in the Sprudel, Schloss-

brunnen, and Muhlbrunnen (which were all the waters at our disposal), and therefore it is probable that as the springs proceed from one common reservoir, all the other minor ones would contain that earth. The presence of lithia is well marked, and amounts in the Sprudel to nearly one grain per gallon.

Sprudel.

	Grains.
Sulphate of sodium	198·05
Sulphate of potassium	4·23
Chloride of sodium	85·32
Acid carbonate of sodium ...	142·00
Carbonate of calcium	20 03
Carbonate of magnesium ...	3·51
Carbonate of iron	0·29
Acid carbonate of lithium ...	0·80
Alumina	1·54
Silica	8·00
Total solids	463·77

The skeleton analysis of this water gives in the half-pint (10 *fluid ounces*).

Total Solids.	Purgatives.	Antacids.	Saline
29 grains.	12½ grains.	10½ grains.	5½ grains.

In the Carlsbad springs we come upon the verge of another class of waters—a class in which the alkaline properties become so marked as almost to throw them out of the same category as those we have previously described ; but still the purgative property remains the chief characteristic. The phenol phthalein give with these waters a strong alkaline reaction even in the cold or in their

normal condition. The presence of lithia is now noticed for the first time.

Schlossbrunnen.

Sulphate of sodium	109·61
Sulphate of potassium	81·70
Chloride of sodium	79·96
Acid carbonate of sodium ...	87·23
Carbonate of calcium	21·45
Carbonate of magnesium ...	2·60
Carbonate of iron	4·90
Acid carbonate of lithium ...	0.40
Alumina	0·25
Silica	4·00
Total solids per gallon	392·10

The skeleton analysis of half-a-pint of this water practically varies very little qualitatively from the Sprudel each 10 fluid ounces contains :—

Total Solids.	Purgatives.	Antacids.	Salines.
24½ grains.	6¾ grains.	7·01 grains.	10 grains.

We now come to a class of purgative waters which, although they mainly owe their activity to one ingredient, yet differ from those just mentioned. Whereas the waters of the Marienbad and Carlsbad type owe their activity to Glauber's salts the following waters will be seen to owe it to the great preponderance of Epsom salts.

Sedlitz Water.—It would hardly do in a work upon mineral water to pass over the springs of Sedlitz in Silesia—yet from a commercial aspect they are of little account. So little is now known of this once celebrated

water that we were not able to get a sample, and, as it is very little used we did consider it necessary to send nearly to Dresden for it. Dr. More Madden in his interesting book on the "Spas," perhaps explains the want of popularity of this water, when he says: "Sedlitz is a wretched looking place, hardly meriting the name of a village, and the wells whence the waters should be derived are a few shallow circular pits whose contents seldom find their way to this country. Instead of the cooling, agreeable draught used in England under that name, the true Sedlitz Wasser is a yellowish, somewhat oily-looking fluid, with a nauseous, intensely bitter taste."

Sedlitz Wasser has no connection with our seidlitz powder except by name; even the indefatigable Baedeker informs us of this "sedlitz gives its name to the now artificially prepared powders which, however, differ materially from them obtained by '*evaporating the mineral waters.*'" The first seidlitz powders, however, were an imitation of what, in those days, was the most well-known mineral aperient spring in Europe. (*a*)

If the following be correct, sedlitz water is a very strong one. Some of the other analyses, which are not so recent, give the total constituents as being higher.

(*a*) Seidlitz powders probably came into vogue about sixty or seventy years ago. In the 5th Edition of "Paris Pharmacologia" we find them mentioned as "the patent seidlitz powders." They had the same composition then (1822) as those now in use. That is to say, a mixture in one packet of acid, carbonate of sodium, and Rochelle salts, whilst the other contains tartaric acid, the result does not resemble the natural water in the most remote degree. When mixed it gives, in solution, Rochelle salts, a double tartarate of soda and potash ($NaKC_4H_4O_6$) with neutral tartarate of sodium ($Na_2C_4H_4O_6$).

According to an analysis of M. Steinman, sedlitz water contains in the gallon :

	Grains.
Sulphate of magnesium	795·5
Sulphate of sodium	174·4
(There is no sulphate of sodium given in the other published analyses.)	
Carbonate of calcium	52·9
Carbonate of magnesium ...	2·0
Carbonate of strontium	0·09
Sulphate of calcium	41·40
Sulphate of potassium	44·10
Chloride of magnesium	10·60
Carbonates of iron and magnesium	0·50
Silica	0·50
Total	1121·99 grains

Skeleton analysis of half an imperial pint (10 *ounces fluid*).

Total solids.	Purgatives.	Antacids.	Salines.
70 grs.	61 grs.	$3\frac{1}{2}$ grs.	$2\frac{3}{4}$ grs.

We also give the analysis of a water in the Sedlitz district, said to be by Berzelius, and which has very curious composition. It runs thus :—

Saidschutz Water.

	Grains.
Sulphate of magnesium	841·6
Nitrate of magnesium	251·7
Carbonate of magnesium ...	49·8
Crenate of magnesium	10·6
Chloride of magnesium	21·6
Sulphate of potassium	40·9
Sulphate of sodium	468·0
Sulphate of calcium	100·9
Oxides of magnesium and iron ...	2·8
Tin, traces	
Copper, traces	
Total solids	1787·9

We merely give this analysis as we are on the subject

of the Sedlitz district, because, if correct, the water is unique, and we know of no water of this character containing 250 grains of nitrate of magnesium. It is occasionally imported into this country. The presence of copper and tin is also peculiar, but would be easily accounted for by the occurrence of mineral veins in the district from which this water is procured.

Birmensdorf.

Birmensdorf water is a mild aperient which owes its activity almost entirely to the magnesian salts. It is rather pleasant to taste, although slightly bitter. Birmensdorf water is imported from a high altitude (1,300) in the centre of the Swiss Lake district, on the road from Zurich to Lucerne. It seems to be a remarkable pure water, and will, no doubt, find its way into general use. The sample examined was perfectly free from organic impurities of a nitrogenous nature. It gave on analysis :—

	Grains.
Sulphate of magnesium ...	1459·03
Sulphate of potassium	19·20
Sulphate of sodium	590·39
Sulphate of calcium	89·98
Chloride of magnesium ...	31·80
Carbonate of calcium	0·60
Carbonate of magnesium ...	9·02
Carbonate of iron (ferrous salt) ...	12·03
Alumina (trace)	1·20
Silica	2·30
Total solids per imperial gallon	2215·55

Our analyses differ so very much from those formerly published, that we subjoin one.

Bolley's Analysis of Birmensdorf Water.

Sulphate of potash	1·04
Sulphate of sodium	70·35
Sulphate of lime	12·69
Sulphate of magnesia	220·01
Chloride of magnesia	4·60
Carbonate of lime	0·13
Carbonate of magnesia	0·32
Magnesia crenic	1·01
Peroxide of iron	10·10
Alumina	0·27
Silica	0·30
Total solids	320·82

We presume this means parts in 10,000 parts.

As regards the amount of magnesian salts Bolley's analyses does not represent the Birmensdorf water as now bottled, and its general constituents differ. The iron is not likely to exist in this water as ferric oxide, and was probably originally in the form of ferrous carbonate—as a matter of fact we found the iron in a partially oxidised state, but a considerable quantity still remaining in the ferrous state.

We find that Birmensdorf water is decidedly chalybeate, but not to the same extent as given in Bolley's analysis.

Crenic acid (magnesia crenic ?) is an indefinite term—which we think is erroneously applied to the organic

matters in waters. It is used for all kinds of organic matters found in waters. (Crenic acid is derived from κρήνη, a spring.) Berzelius said that it was nitrogenous therefore, a water containing it should yield albumenoid ammonia on distillation with permanganate of potassium. Mulder says it does not contain nitrogen, and gives the formula C_{12} H_{12} O_8 as representing that substance. It has really never been procured in a sufficiently definite state of purity to justify us in formulating its composition.

We give the skeleton analysis based upon our own investigations.

Skeleton analysis of ½ pint (10 *fluid ounces*).

Total Solids.	Purgatives.	Antacids.	Salines.
138½ grains.	136½ grains.	1¼ grains.	1¼ grains.

This water is neutral to phenol-phtylein and tropeoline, but on boiling it becomes alkaline, and remains so after cooling. This is not due to the amount of antacids present, which we find are extremely low, but is due to the large amount of magnesian salts present. All magnesian waters behave in a similar manner, and present a great contrast in this respect to the Marienbad water, which owes its activity to soda salts.

Since we had arranged our purgative waters into what may be called a kind of classification, based upon their chemical composition, we have received two others, which, although now given, do not appear in their proper place, we insert them because they have been introduced with some success into this country, and are yet comparatively new to the profession. One is Mattoni's Royal Hungarian

Bitter Water, a strong purgative, owing its activity to both sulphate of magnesium and sulphate of sodium ; and the other, Aesculap Bitter Water, also from Hungary, a mixed purgative with well-marked antacid reactions.

Aesculap Bitter Water of Hungary.

Sulphate of magnesium	1750·3
Sulphate of sodium	1340·7
Ammonia (free)	0·3
Sulphate of potassium	3·5
Sulphate of calcium	185·6
Chloride of sodium	301·3
Bi-carbonate of sodium	140·3
Carbonate of calcium	1·9
Carbonate of magnesium	12·0
Carbonate of iron	3·5
Alumina	5·6
Nitrates (minute trace)	
Silica	1·6
Total	3746·6

The skeleton analyses gives in each half-pint, or ten ounces :—

Solids.	Purgatives.	Antacids.	Salines.
235	195	15	20

The Aesculap bitter water is a good strong aperient water of the mixed class (soda and magnesium salts) On boiling it exhibits an alkaline reaction, with phenol-phthalein, which is permanent. It will be found a valuable addition to our list of purgative waters, as it is pure. However, we think that it would be judi-

cious to remove the amusing error which has crept into the advertisement, and which is evidently taken from the original label. It is stated that it contains salicylic acid. We need hardly remark that it does not contain a trace of salicylic acid, and that what is intended is silicic acid, an ingredient found in all mineral waters.

The Aesculap spring possesses the decided advantage, that it is not so unpleasant to take as many of the other bitter waters, and is free from organic impurity.

Mattoni's Royal Hungarian Water.

Sulphate of magnesium	1228·03
Sulphate of sodium	1016·52
Sulphate of potassium	19·30
Sulphate of calcium	103·06
Chloride of sodium	201·81
Acid carbonate of sodium	129·32
Carbonate of iron	0·63
Silica	0·32
Nitrates and nitrites (N_2 O_5) ...	3·30
Free ammonia	0·80
Albuminoid ammonia	0·12
Total	2703·21

This water has been recommended both in its own country, and in this particularly, by the *Lancet*, *Medical Times and Gazette*. We cannot endorse all that has been said in its favour for the following reasons. It is a very strong purgative water of the mixed class, but it presents undoubted evidence of containing surface drainage, or something equivalent in the form of decomposing organic matter. The presence of *small* quantities of nitrates we

would not object to, but the fact of notable quantity of albuminoid ammonia and nitrites also being present, all point to one conclusion. Nitrites could hardly be present if decomposing action were not in process at the time being.

In two out of three bottles which were examined were found both *nitrates* and *nitrites*. A third bottle contained nothing but the first-named radical.

The skeleton analysis gives to each 10 *ounces fluid*—

Total Solids.	Purgatives.	Salines.	Antacids.
169 grs.	140 grs.	76 grs.	8 grs.

CHAPTER IV.

THERAPEUTICS OF PURGATIVE "BITTER" WATERS.

We have seen that these waters owe their purgative action to sulphate of magnesia and sulphate of soda. The former of these salts is in daily use, and has largely superseded the latter with many practitioners. It is sometimes said to be less nauseous than the soda salts, but this will not be admitted by all, and in pharmaceutical draughts the difference in the flavour may not be perceptible. The soda salt certainly suits many patients who cannot so easily take the magnesian, and perhaps we may admit the reverse statement as applied to other individuals. The soda salt can be given in larger quantities and continued longer than the magnesian. The fact that soda forms so important a part in the economy seems to indicate that its salts may be less obnoxious than those of other alkalies or alkaline earths. Nevertheless, soda may easily be introduced in too large quantities or continued over too long a period, and so bring about injurious results.

The two sulphates act then in a similar manner ; they are often advantageously combined in ordinary prescriptions and we find the two frequently present in the most valuable mineral waters. We need not enter here on a discussion as to their mode of action. The experiments of Thiry and Radziejewsky satisfied them that all purgatives merely increased peristalsis ; but those of Moreau

and Vulpian, confirmed by Brunton, are inconsistent with this conclusion. It is perhaps a fair statement to make that the experimental evidence as a whole supports, if it does not prove the correctness of the impressions derived from clinical observation, that both these purgatives promote secretion as well as increase peristaltic action. At any rate, with regard to the chief purgative mineral waters the writer is satisfied that this is the case, though inasmuch as their constitution is complex, the relative action of each ingredient is open to discussion. Still, as these waters are taken in their natural complex state, it is as such purges we have to consider their uses.

These waters may be taken in single doses as occasional purges ; or a series of doses may be taken at regular intervals in imitation of the method pursued at the springs. In the former case the prescriber is merely desirous to produce the effect of an ordinary saline purgative, and for this purpose the stronger waters will be found most suited. The analyses furnished in the preceding chapter show that some of these contain as much as 200 grains of purgative salts in half a pint of water the effect of which is reinforced or modified by an equal or larger quantity of other solid ingredients—the salines being specially important. It is true that as much or more sulphate of magnesia, or of soda is often given in a draught, but it is not correct to infer that a simple solution of either salt in a small quantity of water is the best way of giving it, or may be fairly compared with other methods. The admirers of mineral waters sometimes make rash statements as to their wonderful powers in comparison with their ingredients. It is curious to see how the repetition of such statements seems to produce conviction and their occurrence in quarters where we

might expect their value to be more carefully weighed seems to call for criticism. It is only those who have paid little attention to posology and still less to the modifying influence of one drug over another, who will be ready to endorse the notions of some advocates of mineral waters in reference to the doses of their ingredients.

In using these waters as occasional purgatives they may sometimes be given in three or four successive doses, frequently repeated, until a certain degree of purgation is attained, just as a cathartic mixture is often given in divided doses. After what has been said it will not be necessary to attempt to indicate the numerous cases in which the waters may be employed in single doses, but we may remark that some of these are well adapted for family use, and would replace with advantage the "antibilious pills" and quack preparations which are the bane of domestic medicine.

When the waters are taken regularly after the fashion at the Spas, other and more important effects are produced, varying greatly with the state of the patient, the doses administered, and the observance or neglect of the conditions usually imposed on visitors to the springs. Without for a moment disparaging the accessory benefits which arise from visiting the spas and undergoing the regular "cure" as formulated by experience, it may be stated that in many cases it is possible to obtain a considerable proportion of the benefit by means of a systematic course of the bottled waters at home. This is especially the case with purgative waters, and we are anxious to draw the attention of the profession to this therapeutical resource. There are many patients who would probably be greatly benefited by a season at a Continental spa who cannot possibly undertake the

journey; there are still more to whom the trip is so exceedingly difficult as to be almost impracticable; and a still larger number to whom it is so distasteful or otherwise objectionable that they are very reluctant to go. Some of these could easily visit an English spa such as Cheltenham or Leamington, and could supplement the treatment there by imported mineral waters. Others could carry out a course of treatment at any English health resort. Hydropathic establishments might be utilised in the same direction, and the writer would urge on the medical superintendents of such places the propriety of making themselves conversant with the subject and being ready to carry out such a course as might be advised by their patients' physicians. Other cases would do better at the sea-side during the course. Lastly, hundreds to whom either of these plans are not adapted, might derive much advantage from such a course at home. But in all these cases the course should be properly and efficiently carried out under medical superintendence, and the more the surrounding conditions of the patient can be made to resemble those imposed on frequenters of the spas, the greater will be the probability of success.

What, then, are the effects produced by a series of doses of saline aperients such as we find in these bitter waters? Much depends on the doses, the circumstances under which they are taken, and the condition of the patient. We can so regulate the administration as to obtain the mildest laxative effect, or we may push it in drastic doses until it proves dangerous. Some patients obtain from a small dose each morning a comfortable evacuation without irritation; others find that a degree of diarrhœa is always produced after a few doses. The fact is these salts are unquestionably irritants, and it is

natural to expect that continuous doses will set up gastric and intestinal catarrh. This is their ordinary aperient action. They pass rapidly through the stomach into the intestines on which their chief action is expended, and are removed for the most part with the fæces. Taken warm, properly diluted, they scarcely affect the stomach at all, but large doses are apt to disturb it. A good deal of mucus and albumen is removed in the artificial diarrhœa set up, besides which biliary matters and digestive products are found in the excretions. Thus, it is clear, the bowels are more rapidly emptied, and the aliment may be so hurried through as to prevent the proper absorption of the nutritive parts. In this way assimilation is interfered with. At the same time tissue metamorphosis is increased. All this accounts for the uniform experience that courses of bitter waters cause loss of body weight, and particularly decrease the fat. If pushed too far, they may no doubt produce extreme emaciation, but much depends on the digestion. If the food supply is sufficient to make up for the extra waste and the waters do not unduly irritate, there may be no loss of weight so long as the digestion is good, the matter removed being replaced by fresh nutriment. Thus it will be seen that the regulation of the diet is of extreme importance if we would obtain from these waters the greatest benefit with the least disadvantage. As to other systems, only a small proportion of the sulphates is absorbed. Some of the sulphuric acid escapes through the kidneys, but the urine contains less nitrogen, though this is probably only because a larger amount of that element is being carried away through the bowels. On muscular tissue magnesia and soda have little effect compared with potash, and the refrigerant action of the salts can scarcely

be due to their effect on the heart. The soda salt, if not the magnesian, also diminishes the coagulability of the blood. But with regard to the less marked powers of the waters, the chloride of sodium and other salts found in most of the purgative waters are of as much consequence as the sulphates.

From the preceding considerations it may be inferred that these waters may be used to unload the bowels and to quicken the passage of materials through the intestines ; to promote tissue changes, and to remove superfluous fat ; to relieve the portal system and to deplete by causing increased serous flow, and in the same way to promote absorption and elimination. The extent to which either or all of these objects may be obtained differs with the individual waters, and the mode in which the course is regulated. The special conditions to which they are adapted will be best considered in reference to the particular waters. These we will now consider, taking first those which contain both sulphates, then those containing only one.

Friedrichshall Water.—This is an excellent aperient water, of medium strength, containing both soda and magnesia sulphates, modified by no inconsiderable amount of chloride of sodium. The remarkable fact discovered by our chemical colleague that the bottled water contains much more of the salts than previous analyses indicated goes far to account for the efficiency of the purgative action. It will also help us to dissipate the error so sedulously propagated that mineral waters possess a mysterious power of increasing the action of their ingredients. Even Sir H. Thompson, in the lecture quoted in the last chapter, has adopted this unfounded notion. Having calculated that his dose of Friedrichshall contains

only twenty-five grains of each of the sulphates, he says that quantity "taken in any combination out of a druggist's drawer would have no appreciable action." This is only a forcible way of putting a statement often made about mineral waters, and which we do not hesitate to pronounce erroneous. We have no difficulty whatever in getting a marked effect from such doses of these drugs. If Sir H. Thompson will take these salts in the same state and under the same circumstances as he gives them in the waters he will soon modify his opinion. Of course, to send them in an ounce draught with a little flavouring is not the acme of medical or pharmaceutical skill. This much, taking the analysis as in Liebig's time; but in future it must be remembered that the water now imported contains a third more salts. See analysis in last chapter. Friedrichshall is, then, a very good household aperient, of which a dose may be taken when required with as little inconvenience as any ordinary saline purgative. But the water may still further be utilised for subjecting patients to continuous doses in the manner already indicated. It is more active than Carlsbad, and for that reason more convenient for this purpose, but it should be taken in the same way and a similar regimen enforced.

Dose.—From a quarter to half a tumblerful for adults according to effect desired. For children less in proportion to age. It should be taken an hour before breakfast. The best plan is to add enough hot water to it to make it warm, drink it in this state, and follow it shortly with a cup of weak tea or coffee. Warm milk or broth may in some cases be more advisable. Continuous doses generally require to be gradually diminished, since, as with most remedies of this class,

their effect is more easily produced after a few repetitions. In well-nourished or fat patients, subjects of "biliousness," in plethoric individuals, in hepatic derangements, or torpor of the abdominal viscera or sluggish portal circulation, in lithiasis, in many gouty and some rheumatic n a few hæmorrhoidal subjects a course of this bitter water is very useful provided it is accompanied by a well-regulated diet and regimen.

Pullna Water.—Clinical experience has shown us that this is similar in action, but more powerful, than Friedrichshall. The writer had, however, found that its greater activity had been rather overstated, and was scarcely equal to what might have been expected from the amount of salts. This discrepancy is explained by the new analysis, which shows Friedrichsall to contain more than was previously supposed. It has been stated, we do not know with what foundation, that Friedrichshall water is now concentrated by evaporation before bottling. Comparing the analyses now furnished, we find Pullna, with less total solids (as 112 to 192·4) has more purgatives in the proportion of 104·5 to 84·7. It has also nearly three times as much antacids, but the total amount of these is of little import. The alleged presence of lithium is shown to be a fallacy ; but far more important is the discovery that the bottled water now in the market is contaminated with organic impurity. The owners should take the hint, and at once set their houses in order. We confess we shall be more disposed to employ one of the other waters, especially for long courses, until this impurity is got rid of.

Dose.—Three to five ounces as an occasional purge for adults. For continuous doses a wineglassful, to be mixed with warm water, and taken before breakfast.

Rákóczy is twice as strong as either of the preceding waters, containing 200 grains of purgative salts in the half-pint, as against 104·5 in Pullna, and 84·7 in Friedrichshall. It is therefore well adapted when a more rapid laxative action is desired, especially as an occasional purge. It is a very useful family medicine, and the dose is smaller than that of the less concentrated waters. Sufficient hot water may therefore be added to raise it to as high a temperature as can be comfortably drunk, without at the same time making the dose too bulky. Then the considerable percentage of lithia in this water makes it specially appropriate for gouty and rheumatic patients, who may require a saline purgative. In the numerous disorders attributed to hepatic derangement, in lithiasis, and as a promoter of tissue metamorphosis, it may also prove useful. A little iron and a trace of fluorine discovered by Mr. Tichborne may also give some peculiarity to this water. For continued use the quantity taken should be small, and gradually decreased. We do not often advise it in this way unless as a supplement to a course of less powerful waters, such as Leamington or Cheltenham, and for this purpose it is very useful.

Dose.—As an occasional aperient, half-a-wineglassful to a wineglassful diluted with hot water first thing in the morning, followed by a cup of tea. For continuous use a less quantity may be taken, either at bed-time or in the morning, diluted with hot or cold water.

Hunyadi János is only a little weaker in salts than Rákóczy, is equally antacid, and may be given in similar doses and for similar purposes. But it contains no lithia, and therefore has not the special indication furnished by that alkali. On reference to the analyses it will be seen that this water contains very much less magnesium sul-

phate, but only a little less total purgative salts than the last, inasmuch as there is a larger proportion of sodium sulphate.

Dose.—As an occasional purgative half-a-wineglassful to a wineglassful, with an equal quantity of hot water before breakfast. For continuous use the dose should be gradually decreased, and it may be taken either at bed-time or in the morning, as the patient prefers.

Aesculap Hungarian Bitter Water.—This spring may claim to be the chief of the Ofen group, for, with only five grains less of purgatives than the highest in our analyses, it is three times as rich in antacids, but it contains no lithia. Its proportion of magnesian sulphate is higher than the soda salt, of which it contains less than either of the Hungarian waters named. It contains, however, nearly three times as much chloride of sodium, and so approaches nearer those waters in which this salt is an important ingredient.

Dose.—As an occasional aperient, a wineglassful or two, diluted with hot water, first thing in the morning, followed by a cup of tea. For continuous use a less quantity may be taken, either at bed-time or in the morning, diluted with hot or cold water. The addition of a lump of sugar and a little lemon-juice completely covers the flavour of this water.

Mattoni's Royal Hungarian Bitter Water.—The chemical characteristics of this water have been already stated (p. 50), and supply sufficient information respecting it.

Seidlitz.—This is a weaker water, containing only 61 grains of purgative salts in the half-pint, and yet this is sufficient to have obtained for the spring a high reputation which lasted many years, though it is now comparatively

fallen out of use. Our chemical colleague says it contains a good deal of sulphate of sodium, though other analyses do not mention this, and accordingly its action has hitherto been attributed entirely to magnesium sulphate, of which it contains much more.

Saidschutz.—From the same district as the last-named water is a little stronger. The analysis of Berzelius (quoted p. 45) assigns a larger proportion of nitrate of magnesia to this than to any similar water.

Birmensdorf is an excellent bitter water containing also the mixed sulphates but the magnesium salt greatly preponderating, though there is enough soda to give it some character. It contains more sulphate of magnesia than Friedrichshall or Pullna, but less than Rákóczy or Hunyadi János. On the other hand it has less sulphate of soda than either of them. It will thus be found useful when either of the other bitter waters are rather too powerful, and may often be preferred when it is desired to continue the use of a purgative water, and the Epsom salts is not contraindicated.

Dose.—About half-a-tumblerful diluted with warm water.

Other mixed Bitter Waters may be mentioned. Some, as *Kissengen* and *Uriage* may be almost regarded rather as salt waters with a small quantity of purgatives. The glory of the *Epsom* spring has departed, but its fame has fixed its name on the chief ingredient of the majority of purgative waters. Other English spas, as *Beulah, Streatham, Purton, Scarborough,* and above all *Cheltenham,* belong to this class, and are deserving of more attention than they now receive, especially as the waters when found not strong enough can be reinforced with one of the stronger importations, as we have already pointed out.

Cheltenham, too, might well be preferred as a residence for a season to many foreign resorts, and between its climate and that of Scarborough the majority of patients needing such a course of saline purgatives as we have described might be well suited.

Leamington is another beautiful resort, but its waters contain no magnesium sulphate, and therefore more properly belong to our next group, the efficacy of which is due to Glauber's salts.

"Glauber's Salt" Waters.

We now come to a group of waters distinguished by containing sulphate of soda, but none of the corresponding salt of magnesia. We have seen that there are numerous cases in which either or both of these saline purgatives are useful. There are others in which the soda salt is more appropriate. It is very often stated that Glauber's salt is more nauseous and also more irritating than Epsom salts, and some attribute the popularity of the latter to these qualities. Not only are both these assertions disputable, we consider that the reverse of them would be nearer the truth. It is possible some persons may consider one salt less nauseous than the other. *De gustibus non disputandum.* But with regard to their relative efficacy it is more important to have a correct idea. We have no doubt whatever that the magnesian sulphate is more irritating to the intestinal mucous membrane than the soda salt. When taken alone, the former may be considered half as strong again as the latter, and many persons will find it act twice as powerfully; but in mineral waters it is not alone. The carbonate of soda, chloride of sodium, and even the carbonic acid modify the action. The effect

of the waters is therefore a complex one. For single purgative doses this may not signify, but for prolonged courses it is of great importance. Glauber's salt acts in the same manner as Epsom salts, but is less irritating. It can be given in large quantities. Accordingly, its single dose is larger, but for continuous use the ratio is not the same. It may be pushed until the artificial diarrhœa becomes distressing, but this is not so soon the case as when the mixed salts are employed. The so-called "critical diarrhœa" about which so much has been written, is the natural result of continuing too large doses of any of the purgative waters, although it may also be brought on by errors in diet, or by taking cold. In the leading mineral waters, however, considerable influence must be assigned to the modifying ingredients. Of these, carbonate of soda is perhaps most important. It is a most effective corrigent, and may perhaps claim to serve also as an adjuvant. It will be readily admitted that the corrective influence on the stomach may be serviceable, but we believe this influence extends along the intestines. Anyone who has much experience in the treatment of irritative diarrhœa, by alkalies, will admit this. But, then, we ought not to forget the effect of this carbonate as a solvent of the albumen of the blood, and thus as a promotor of serous transudation. If this be increased, we can easily see that a minor degree of stimulus to the intestine should suffice to produce purgation. In the same way chloride of sodium may be shown to be a more important ingredient than is sometimes supposed. It stimulates gently the mucous membrane of the alimentary canal, and also the muscular fibres of the intestines; when absorbed it promotes tissue change, and apparently

aids in cell formation. Its digestive action is well known. These two salts are therefore admirably suited to reinforce the sulphate, and the mineral waters thus constituted are remarkable for their efficacy as well as for their mildness. Further, on account of the carbonic acid which they also contain, they act more easily on the stomach and are more acceptable to the palate.

In these waters, then, we have saline aperients which are powerful promotors of tissue metamorphosis. They cause a sensible decrease in the body weight, chiefly by the loss of superfluous fat, for the muscles do not diminish in volume, and the appetite, digestion, and assimilation, improve under their judicious use. It is only when pushed to extremes, or in unsuitable cases, that injurious irritation is set up. The increased tissue change would thus appear to be counteracted by the removal of fat. At the same time we must admit there is also considerable increase in the elimination of nitrogenous material through the bowels. This is partially compensated for by decrease in the elimination of nitrogen by the kidneys, which Prof. Seegen has shown to be produced; though, as will be seen, we do not accept the view he advances, that there is an absolute reduction of eliminative activity, but regard the lessened removal by the kidneys as more than counter-balanced by the bowels. In the use of such agents it is obvious that diet and regimen are of the utmost importance, and at the principal spas these are regulated with no slight rigidity. Some further details will be given under the individual waters.

Carlsbad, the only hot spring of the group, is the most important, on account of its remarkable position, its ancient repute, and the valuable researches which have

been accumulated respecting the therapeutical effects of the waters. As early as 1522, Dr. Payer produced his *Tractatus de Thermis Caroli, IV.*, and about half a century later Dr. Sumner published the composition of the waters. Drs. Schackern and Springsfeld showed the remedial uses of the waters, and in 1772 appeared Dr. Becher's *Neu Abhandlung von Karlsbade.* The last-named author appreciated to a remarkable degree the qualities of the waters, and the cases for which they were adapted. Some of his observations might well be thought to have been recently written. Many eminent physicians have since discussed the subject in all its bearings, and Dr. Seegen still continues his important experiments.

Carlsbad is not adapted for use as an occasional purgative. The dose would be too large, and, indeed, some authors distinctly deny its purgative action ; but the first few doses almost invariably produce increased alvine evacuations. Still the best and most lasting effects are obtained from moderate doses. At the springs it seems to be a common practice to gradually increase the dose, which varies from two to ten glasses of six to eight ounces each. The whole quantity is taken before breakfast, walking in the open air between the glasses, the drinking thus occupying an hour, or an hour and a-half. The dose, small at first, is increased until several fluid evacuations are produced, and this degree of purgation may be kept up, or the quantity again reduced according to circumstances. It is obvious that a course of such treatment prolonged for weeks is a very powerful therapeutical process, especially when reinforced by appropriate diet. This last point is much insisted on at Carlsbad, and those employing these or other saline waters will do well to adopt a dietary approaching in character that

which is there enforced, and which we may as well briefly state :—

Breakfast (to be taken an hour after the last glass of water)—weak tea or coffee with milk and a little sugar, well baked rolls or stale bread, no butter; eggs, bacon, fish, or meat only permitted to very weak patients. *Dinner* (at one o'clock)—Soup free from grease or flavouring, but may be thickened with rice, vermicelli, or pearl barley ; meat (beef, mutton, or lamb), or poultry, with well-boiled fresh vegetables, a light pudding, or stewed fruit. A cup of coffee is allowed in the afternoon, and a light *Supper* at eight o'clock. Light claret is only allowed in small quantities when the physician thinks a stimulus to the stomach needful. Otherwise, alcohol is absolutely forbidden. Smoking in moderation is tolerated. The following articles are forbidden : butter and fats of all kind, cream, cheese, pastry, pork and other rich foods, goose, sausages, salmon, herrings, anchovies, mackerel, *entrées*, and all seasoned dishes, peppers, onions, garlic, spices, cucumber, all salads and uncooked fruit.

This somewhat primitive and rigid diet would, without any other measure, produce a great effect in many persons, and in several points may often be relaxed. The absolute prohibition of butter, for instance, would often be a hardship, and its exclusion is not justified by science. It is only *excess* of fat that is injurious to digestion ; some of it seems actually to accelerate the formation of peptones, and the amount which thus facilitates digestion may well take the form of butter. In the same way the exclusion of ripe fruits and vegetable acids—originally founded on an error—need not be insisted on unless for some special purpose. Again, there are cases in which the meals

should not be limited to three daily, and there are others in which the waters and the exercise make too great a demand on the strength of the patient unless a cup of tea or milk-and-water be permitted to precede. But while making these concessions we must urge the importance of a simple diet, carefully regulated on the lines laid down at Carlsbad.

In employing the bottled waters it is well to follow, as far as circumstances permit, the plan pursued at the Springs. The water should be warmed to 100 F. or higher. This may be accomplished by adding boiling water, or if that should increase too much the bulk of the dose, by allowing it to stand in hot water long enough to warm it. The original bottle should, however, on no account, be heated. So, the quantity to be taken should be distributed over about an hour's active exercise, out of doors if possible. In some delicate persons it may be desirable to permit a cup of weak tea or warm milk, or milk and water to precede the dose, but the rule is to take it fasting. When only a small dose is given and little exercise taken, and that indoors, the fast must be broken by the mineral water. Then as to diet, it is most important for patients to co-operate with the physician, and therefore as much latitude as may be practised without detriment should be allowed. Much depends on the disease, and every case ought to be separately considered. Hence the difficulty of inelastic rules. Following the plan of the spa we may advise simple breakfast, midday dinner, and a light supper. Most people, however, would like tea at 5, and supper a little later, and this may be generally allowed ; the tea consisting of tea with milk, biscuits or dry toast. It would also be better to remove the soup from the dinner

which should consist of two courses only, viz., meat, or poultry, or game, with vegetables, followed by light pudding. This would allow greater variety in the supper. We would also admit butter in moderation for breakfast. Ripe fruit, too, might very often be taken with advantage. These relaxations would be welcomed by most patients, and in the majority of cases would do no harm, while in some special conditions other changes ought to be made. But no concession can be made to the lovers of malt liquors. The prohibition of alcohol should be absolute. Generally, even in moderate doses the waters act on the bowels, producing each day one, two or more copious, pulpy, slimy evacuations, which are sometimes of dark colour and offensive smell. Many patients are astonished at the quantity of material thus removed. Sometimes however, only a slight purgative effect is produced. The dose should be regulated so as to secure one, two or three full, soft stools soon after it, the bowels being at rest afterwards until the next morning. This may be kept up for three or four weeks or longer as may be necessary. To carry out this plan it may be necessary to give 2 or 3 glasses to begin with, and increase to 6, 8, or more before the full action is obtained, and then to diminish until the point is found which will keep up the effect desired.

A milder course of the bottled waters is sometimes of great value. This may be attained by taking every morning a dose of about half a tumblerful. In this case the glass should be filled up with water hot enough to bring the whole to a temperature at which it can be drunk. This is to be taken first thing in the morning, or sipped during dressing. It may be followed up by a cup of weak tea and a walk or gymnastics until breakfast—an hour

after the water. These mild courses ought to secure one soft evacuation daily. In many cases it is desirable to precede the course by one or two doses of an alterative.

It is in disorders of the abdominal viscera that Carlsbad is chiefly recommended. In the "abdominal plethora" of the Germans, in the bilious and liver complaints of many English practitioners it has been employed with success. The remarks we have made on its general effects will enable the reader to understand why this should be the case, as well as why it should prove serviceable in corpulency. In lithiasis, in concretions of uric acid and catarrh of the urinary organs, and in gouty states, when the abdominal circulation is sluggish, the alkaline quality of Carlsbad indicates it in preference to many other salines, and from the new analysis of Prof. Tichborne we find that these waters contain lithia—the alkali which is specially suited for these conditions. The discovery is one of great interest. Carlsbad is also recommended in hæmorrhoids, provided the patient be corpulent, possess sufficient stamina, and is relieved rather than injured by the occasional bleeding caused by the malady. But in weak and emaciated subjects, with tendency rather to atrophy than engorgement of the liver, and who, instead of finding relief, are made much worse by the loss of blood, all purgative saline courses are contra-indicated. In enlargement of liver or spleen due to malaria, or in congestion of these or other viscera from overfeeding and want of exercise; also in tendency to gall-stones; in most ailments due to sluggish portal circulation, the treatment is effective. It may also be employed to deplete in venous engorgement. In disorders of the stomach and bowels it might seem less applicable than other waters, but it is often used in catarrhal states of the mucous membrane. Lastly, Dr. Seegen re-

ports good results in diabetes. It would seem those cases of this disease should be preferred in which the abdominal viscera suffer, while Vichy would be more suitable for other cases. But we need not dwell on this point, as the imported water is not likely to take more than a very subsidiary part in the management of this disease. In female diseases, if dependent on abdominal engorgement or sluggish portal system, the mild course we have sketched above is often a potent auxiliary to other treatment; and the same may be said wherever there are indications for a course of gentle saline, alkaline, purgative waters.

The Sprudel is the most generally used spring, and, from our analysis, seems to give the most concentrated water. It is richer in purgatives as $12\frac{1}{2}$ to $6\frac{3}{4}$, and the dose should be smaller. A more important indication is that it has more antacids than the Schlossbrunnen, 10·5 to 7·01. In these antacids we notice that the Sprudel has double the quantity of lithia, and the carbonate of soda is also in much greater quantity than in the Schlossbrunnen. The latter, then, should be used where the milder effects are desired, but the Sprudel for obtaining the full action of the waters, especially in gouty subjects, or where alkalies are indicated.

Marienbad.—These waters resemble those of Carlsbad, but are more concentrated, and contain more carbonic acid. The springs are also cold. These differences are all in favour of the exported waters, as they should in consequence be bottled with less change, and keep better. The dose, too would be smaller. A study of the analyses indicates what has been found by clinical observation—that Marienbad and Carlsbad may often be made to serve for each other. Marienbad is, in fact, cold Carlsbad, but

stronger; or, to put it in the opposite way, Carlsbad is hot Marienbad, but weaker. The two spas are thus, to some extent, rivals. Marienbad, indeed, makes no claim to help diabetic patients, though, on the other hand, she vaunts the iron in her waters, and holds them to be more tonic. We do not think iron of much value in this class of waters, for it is at once precipitated. The considerable amount of carbonic acid in Marienbad is also said to make it stimulant, and it certainly is agreeable to both palate and stomach. To this gas is probably due the repute of the waters for being easily digested, although cold. On the other hand, the disengagement of carbonic acid in the stomach sometimes is a disadvantage, but then the water may be allowed to stand. In these cases, too, it is usually better to give warmer waters, but Marienbad will bear dilution with hot water for this purpose, as it is richer in antacids, as well as aperients, and each of the springs contains lithia. Thus, the cases are numerous in which either spa would be beneficial, the chief differences being regulated by the temperature, and degree of concentration of the waters and the amount of the gas present. Where the aperient action is most desired and a cold spring is suitable, Marienbad is preferred. In weaker persons, with poor circulation and defective heat-producing energy, in catarrhal conditions of the alimentary canal, and where carbonic acid is not agreeable, Carlsbad is preferred.

The use of the bottled waters may be inferred from what has preceded. Marienbad is a stronger Carlsbad, and may be substituted for it when it is desired to increase the effect of the purgative and antacid ingredients; but where the bulk of larger quantities of Carlsbad is objectionable, Marienbad may be given cold, or it may be warmed suffi-

ciently without losing all its carbonic acid. Further, by diluting Marienbad with rather less than its own bulk of hot water, we obtain a draught closely approximating warm Carlsbad, as may be seen from our analyses, which give, in 10 oz. of the Ferdinandsbrunnen spring of Marienbad—22 grains of purgatives, and 18½ antacids, as against 12½ of the former and 10½ of the latter in the Sprudel of Carlsbad. The dose is to be regulated accordingly. A mild course, such as that sketched in our remarks on Carlsbad, may be begun by a morning dose of two-thirds of a tumblerful, filled up with *hot* water. If, after two or three days, this does not act on the bowels, the quantity must be increased. The diet and regimen advised under Carlsbad must be observed.

Tarasp has become more known in England of late years, and belongs to the same class of waters. It contains as much sulphate of soda as Carlsbad, but nearly three times as much carbonate, and more than three times as much common salt. Where more antacids and salines are required it is therefore available. The adjuvants seem to increase the aperient action of the Glauber's salt. The water contains so much carbonic acid that it may be warmed when required. The average dose may be a pint daily, half of which may be taken before breakfast, and the remainder between that and a mid-day dinner. Tarasp is by some advised in bronchial and pulmonary affections, complicated with abdominal stasis. But the question of climate here occurs, and at present we are only dealing with the bottled waters. These may be used instead of Carlsbad, bearing in mind the differences we have stated.

Franzensbad is a cold spa, the strength of which is

between that of Carlsbad and Marienbad, but it contains less carbonate of soda than either. It is sometimes called chalybeate, but contains little iron, and that, as we have seen, is not important in waters of this kind.

Elster (Saxony) resembles the last, containing a little more sulphate and a little less carbonate of soda. *Füred* and *Stubnya*, in Hungary, *Rohitsch*, in Styria, and *Bertrich* (Mosel) belong to this group, but are weaker. All are, no doubt, useful to their districts, but it would detain us too long to examine minutely their differences. The physician who has studied the subject of mineral waters will be able to advise respecting any difficult case.

This group of waters, however, must not be dismissed without reference to our own English *Leamington*, which is rich in sulphate, though not in carbonate of soda, and where many of the advantages of a foreign spa may be enjoyed, especially if the waters be supplemented by others. For example, many cases would do well at Leamington if they took small quantities of Vichy, or some other alkaline water. Other combinations might be arranged, but this suggestion should suffice to show the scope of the British Glauber's salt spa.

CHAPTER V.

CHEMISTRY OF THE ALKALINE WATERS.

If the German and Austrian empires luxuriate in the strong purgative waters, France seems to affect the alkaline waters. Perhaps the most well known are those of Vichy which have greatly grown in importance during the late emperor's reign. The waters of Vichy are frequently compared and spoken of in connection with Carlsbad, but nothing could better show the want of a good classification than such a confusion of ideas, for the analogy is not borne out by the analyses.

In the Vichy waters the alkalies are in about the proportion of 17 of alkalies to 1 of purgative, whilst the alkaline earthy carbonates are in about the proportion of 3 to 1 of purgatives. Now in the Carlsbad waters this is all reversed. Thus we find that the purgatives proper (we do not include the chloride of sodium), are in about the proportion of $2\frac{1}{4}$ to 1 of alkaline carbonates, whilst there are eight times the amount of alkaline earthy carbonates. It is very evident that such waters must be different in their action.

Vichy Waters.

Vichy is situated at the foot of the Auvergne mountains in France, and as these springs and the corresponding establishments are government property, and as the

bottling is done under government supervision we may presume that every care is exercised in doing full justice to the waters. There are 8 or 9 springs the waters of which are all bottled, but as the area over which they extend is limited it is probable that they have one common origin. This assumption is more or less borne out by the analyses, which show a considerable similarity. We have re-examined four of the most important—Grande-Grille, Hôpital, Hauterive, Mesdames.

The proportion of saline substances brought from the interior of the earth by the waters of the Vichy basin is astonishing. It has been estimated by M. Bouquet at 1,861 tons per annum. The river Allier receives about three-quarters of the precious waste. The geological formation explains, to a certain extent, the remarkable permanence of their chemical composition. But, says the above quoted authority, the mineralisation of Vichy water must be expected to slowly decrease in future—"but without professing to foresee the period at which they will cease to spring forth or will yield water in its normal state, we may safely affirm that such a change will require a series of ages similar to the geological periods, and thus, consequently, thousands of years will elapse before serious modifications, or even an appreciable change will be manifested in the chemical composition, or temperature of these mineral waters."

The writer is inclined to think that already a change has taken place in these waters as will be evidenced by the four analyses subjoined : in no case do we find the analyses give so heavy a result as regards the total solids—when compared with the published results. The discrepancy is not great, but still sufficient to indicate a tendency to a decrease in strength.

In the Thermal establishments at Vichy the flow of the mineral water is about 514·5 litres a day (113 gallons) but during the month of July the daily consumption would exceed this limit. To remedy this periodical extra consumption immense vaulted cisterns have been constructed 12 feet deep, in which the water is stored. This of course, enables the proprietors to keep up a supply commensurate with the demand, and the superfluous water at the hours when there is no great consumption is not lost as it was during the early days of this Thermal establishment. These cisterns will give a supply more constant in its composition for bottling, and if the water was taken in the original analysis from the Springs it would, no doubt, explain some discrepancies.

We have for the first time noticed in the Vichy waters the undoubted presence of lithia, but only in very minute quantities, not anything like the quantity found in the Carlsbad springs. We have preferred marking this down in our analysis as "a trace," because to anything approaching an accurate determination of this base it would be necessary to operate upon very large quantities of the waters, particularly when occurring in small fractions of a grain per gallon. We have, however, we believe, detected lithia in every one of the Vichy waters examined, but in very unimportant quantities. Some of the Vichy waters are procured from artificial borings, these are Vaisse, Saint Yorre, and Larbaud. We have selected for examination those which spring naturally from the Vichy basin. Some of the waters, such as Puits Carré, are only used for baths. Sulphuretted hydrogen is given as one of the gaseous products of these waters, but any trace which they might have contained must have become oxidised, as there is not the slightest indication of that

body in the bottled specimens. They, in fact, contain no alkaline sulphides, and therefore, cannot be considered in the light of sulphurated waters. Hauterive is said to emit the odour of rotten eggs when it issues from the spring. This is one reason that we examined it. No doubt this is all correct, but we should never use them in this country as a sulphurated water. It is probable such waters merely owe their odour to a little gas—not to sulphides.

The Vichy waters all contain arsenic, but in such small quantities that the term arsenical waters will hardly apply. They do not contain a maximum pharmacopœial dose of arsenic ($As_2 O_3$) in a gallon of water.

The most important is Grand Grille, so-called, we believe, from the appearance of the rails originally surrounding the spring.

Vichy Grand Grille.

It contains per gallon—

Bicarbonate of sodium	294·80
Bicarbonate of potash	21·64
Carbonate of magnesium	18·62
Carbonate of strontium	19·01
Carbonate of calcium	26·68
Ferrous carbonate	·30
Carbonate of manganese, trace	
Sulphate of sodium	18·12
Phosphate of sodium	8·00
Arsenic	·09
Boracic acid, trace	
Chloride of lithium, trace	
Chloride of sodium	32·82
Organic matters, trace	
Silica	4·00
Total solids per gallon ...	444·08

Skeleton Analysis of half-a-pint (10 *ounces fluid*).

Solids.	Antacids.	Salines.	Purgatives.
27·¾ grains.	24 grains.	2 grains.	1 grain.

The Grand Grille water is strongly and permanently alkaline even in the cold. It seems to be fairly free from albumenoid ammonia.

The free carbonic acid was not determined, although this and the other Vichy waters retain it with considerable tenacity.

Hauterive.

Bicarbonate of sodium	...	300 grs. per gall.
Bicarbonate of potassium	...	12·08
Carbonate of magnesium	...	32·03
Carbonate of strontium	...	·19
Carbonate of calcium...	...	27·62
Carbonate of protox. iron	...	1·08
Carbonate of manganese, trace		
Sulphate of sodium ...	...	18·60
Phosphate of sodium...	...	3·00
Arsenic	...	·08
Boracic acid, trace		
Chloride of lithium, trace		
Chloride of sodium ...	...	34·15
Silica	...	4·43
Organic matter, trace		
		433·26

Free carbonic acid not determined.

Skeleton Analysis of half-a-pint (10 *ounces fluid*).

Solids.	Antacids.	Salines.	Purgatives.
27· grains.	23·⅓ grains.	2 grains	1· grains.

The Hauterive waters are strongly and permanently

alkaline. They are stated to contain a larger proportion of free carbonic acid gas than the other waters of Vichy; but it is absurd to give in a bottle-water any estimation of carbonic acid gas, as it will always be a varying quantity. We have already drawn attention to the fact that the Vichy waters seem, from their composition, to retain the gas with great tenacity; therefore, they are all good waters for bottling.

Mesdames.

Another Vichy water of some importance.

It contains—

Bicarbonate of sodium	240·30
Bicarbonate of potassium	11·25
Carbonate of magnesium	26·31
Carbonate of strontium	0·20
Carbonate of calcium...	36 01
Ferrous carbonate	2·01
Manganese oxide, trace	
Sulphate of sodium	16·30
Phosphate of sodium...	0·32
Arsenic	0·38
Boracic acid, trace	
Chloride of sodium	21·14
Silica	2·00
Organic matter, trace	
Total	356·22

Skeleton analysis of half-a-pint, or 10 fluid ounces:—

Total Solids.	Antacids.	Salines.	Purgatives.
22 grs.	19 grs.	1 gr.	1⅓ grs.

This water and the next (Hôpital) are supposed to be the most ferruginous of the Vichy springs. It is also

one of the springs which is supposed to give off sulphuretted hydrogen. There was no evidence of the presence of sulphides in the bottle examined; and we must, therefore, presume that those salts had become oxidised. As regards the iron, the small fluctuations in the relative amounts of iron present are probably due to the different temperatures at which the waters rise. Many of the springs, like Grande Grille, are said to be surrounded by an ocherish deposit.

Another of the best known Vichy waters is—

Hôpital.

It contains—

Bicarbonate of sodium	314·26
Bicarbonate of potassium	4.21
Carbonate of magnesium	12·32
Carbonate of strontium	0·26
Carbonate of calcium	36·00
Ferrous carbonate	0·23
Manganese, trace	
Sulphate of sodium	18·32
Phosphate of sodium	3·00
Arsenic	0·07
Boracic acid, trace	
Chloride of sodium	32·32
Silica	3·08
Organic matter, trace	
Total	447·00

Carbonic acid gas, free, not determined

Skeleton analysis of half-a-pint, or 10 fluid ounces:—

Total Solids.	Antacids.	Salines.	Purgatives.
28¼ grs.	25 grs.	2 grs.	1 gr.

Parc.

This is another well-known Vichy water, frequently imported in the bottled form.

It contains—

Bicarbonate of sodium	298·00
Bicarbonate of potassium	18·34
Carbonate of magnesium	13·00
Carbonate of strontium	0·41
Carbonate of calcium...	38·23
Ferrous oxide	0·24
Manganese, trace	
Sulphate of sodium	20·16
Phosphate of sodium...	9·30
Arsenic	0·08
Boracic acid, trace	
Chloride of sodium	28·57
Silica	2·8
Organic matter, trace	
Total solids... ...	429·13

Carbonic acid, free, not determined

Skeleton analysis of half-a-pint, or 10 *fluid ounces :—*

Solids.	Antacids.	Salines.	Purgatives.
$26\frac{3}{4}$ grs.	23 grs.	$1\frac{3}{4}$ grs.	$1\frac{1}{4}$ grs.

This analysis must conclude our notice of the Vichy waters. The others imported are Chomel and Célestins ; but it will be perceived that all the waters, though complicated in character, bear a great resemblance to each other. The complexity of character probably has given rise to their celebrity. At any rate, this is a good example of how difficult it would be to imitate such springs artificially. Presuming it were possible to imitate

them, how very improbable that in commerce such a formula would be adhered to, as would give an analysis resembling the original springs.

As we have now concluded the analyses of the Vichy springs, we wish to make a few remarks upon the bottling of these waters. We do not wish to insinuate that other waters are not bottled equally well, but the Vichy springs being under government supervision, we have an insight into the matter which is not afforded by the general run of information given in other cases. The question of bottling is one of great importance in connection with the importation of mineral waters, and when we observe that very few will stand any considerable time without giving a *sediment,* we see the desirability of dwelling a little time upon this subject.

As regards the Vichy waters, the corking is done by machinery, and good corks are specially selected. There is an excellent system pursued in connection with them which should be carried out with all the others Each bottle is secured with a tin capsule bearing the date of the year when it was bottled. Now, having regard to the change that might take place in mineral waters after keeping for some years, we cannot commend this practice too highly; there is no reason to suppose otherwise than that those waters which contain organic matter would, however well corked, become putrid after a lapse of time, such a change being quite irrespective of the deposition of many of their most active ingredients.

To illustrate the important commercial phase which the importation of mineral waters has assumed — Of Vichy waters alone, in 1866, 2,045,140 bottles were sent out, as against 350,000 bottles in 1853. M. Bouquet states that the average loss of carbonic anhydride in the

bottled waters is about 10 per cent., but from our own observation this loss is very erratic. The last portions, however, of carbonic anhydride, are retained with great tenacity, and as, in most waters, the quantity required to keep the carbonates in solution is very small, the question is really not of so much importance. The iron is generally deposited by virtue of oxidisation, not by escape of carbonic anhydride. Still, all waters should be stored in cool cellars, with as much care as would be expended upon good wine ; and the practice of placing the waters in shop windows, under a broiling sun, or on counters, is most objectionable.

Vals.

The Vals waters are also very well known alkaline springs in Ardèche, France. Like the Vichy waters they are bottled under government supervision, but the system adopted is not so good, the year of bottling not being marked upon the capsules as in the last-named waters. This point is of some considerable importance as the waters are inclined to deposit. The bottle therefore, should be held up to the light, and if it contains any appreciable amount of sediment it should be rejected. There are a great number of springs at Vals, but it will be sufficient to give the composition of a few.

The most important springs are—

Madeleine (S).—Very rich in carbonate of sodium, contains about 350 grains per gallon.

Saint-Jean (S).—Very little mineralised, only containing 175 of total solids per gallon.

Dominique (M).—Similar, but said to contain arsenic and iron in considerable quantities.

Précieuse (S).—Is stated to be the most gaseous. It is the least alkaline of the strong alkaline waters.

Desirée (S).—Similar to the previous one.

Rigolette (W).—Given as containing no magnesia.

It will thus be seen that the Vals waters vary considerably, and that if they were prescribed indiscriminately as "Vals waters," the patient would find a marked difference if, after taking St. Jean (175 grains), he accidentally changed it for Madeleine (350 grains).

The Vals springs are all highly carbonated, and it is probable that they are more suited to consumption at the springs than for importation. M. Candelle in his "Manuel de Médecine Thermale" divides the Vals into strong, medium, and weak, according to the quantity of bicarbonate of sodium that they contain. We have, according to his classification, put "S," "M," and "W against those waters which we have named, but do not wish it to be inferred that we adopt this classification.

We now subjoin our analyses of four selected Vals waters—

Prècieuse.

Bicarbonate of sodium	180·32
Bicarbonate of potassium	7·02
Carbonate of calcium	11·72
Carbonate of magnesium	13·06
Carbonate of protoxide of iron ...	0·34
Chloride of sodium	1·90
Chloride of potassium	0·52
Sulphate of sodium	6·01
Sulphate of calcium	5·60
Alumina	2·03
Lithium, trace	
Organic matter, trace	
Total solids	228·52
Free carbonic acid not determined	

Skeleton analysis of Half-a-pint (10 *fluid ounces*).

Solids.	Antacids.	Salines.	Purgatives.
14·28 grs.	13·27 grs.	·15 grs.	·37½ grs.

Désirée.

Bicarbonate of sodium	165 01
Bicarbonate of potassium	7·12
Carbonate of calcium	9·54
Carbonate of magnesium	13·96
Carbonate of protoxide of iron... ...	0·36
Chloride of sodium	26·72
Chloride of potassium	3·02
Sulphate of sodium	5·41
Sulphate of calcium	6·11
Alumina	1·56
Total solids	238·81

Free carbonic acid not determined.

Skeleton analysis of Half-a-pint (10 *fluid ounces*).

Total Solids.	Antacids.	Salines.	Purgatives.
14·92 grs.	12·24 grs.	1·85 grs.	·35 grs.

This spring and the previous one, with another, Madeleine, may be considered as being very much of the same character, and as being typical of the strong Vals waters.

We find that bottled specimens of Vals waters give such different results from the original analyses, that we subjoin one for comparison, premising that we have converted grammes per litre into grains per gallon.

Désirée (*Ossian Henry*).

Bicarbonate of lime	39·97
Bicarbonate of magnesia	63·00
Bicarbonate of soda	422·80
Bicarbonate of potash	18·41
Bicarbonate of protoxide of iron ...	0·70
Chloride of sodium and potassium ...	77·00
Sulphate of soda	14·00
Sulphate of lime	14·00
Alumina	4·06
Total solids	653·94

We now give our analysis of another of these waters :—

St. Jean.

Bicarbonate of sodium	65·00
Bicarbonate of potassium	1·75
Carbonate of calcium	8·43
Carbonate of magnesium	2·98
Carbonate of protoxide of iron ...	0·30
Chloride of sodium	2·13
Chloride of potassium	0·50
Sulphate of sodium	2·37
Sulphate of calcium	3·07
Alumina	0·50
Total solids	87·03

Free carbonic acid not determined.

Skeleton analysis of Half-a-pint (10 *fluid ounces*).

Total Solids.	Antacids.	Salines.	Purgatives.
5½ grs.	5 grs.	1-10 gr.	1-10 gr.

Dominique.

We have now to consider that curious spring called Dominique, certainly curious when taken in connection with the general composition of the Vals waters ; however, if we take a glance at the analysis of St. Jean, we see that a marked change is evident therein from the previous waters which assimilates it to the Dominique.

The published analysis of the Dominique spring is as follows, per 1,000 grammes :—

Sulphuric acid	1·30
Silicate, Arseniate, Phosphate, Sulphate of Sesqui-oxide of Iron.	
Lithia	0·44
Sulphate of lime	
Chloride of sodium	
Organic matter	
Total solids	1·74 per litre = 121·80 grains per gallon.

Our analysis give us the following results, in grains per gallon :—

Carbonates of calcium and magnesium with iron precip. on boiling... ...	5·00
Silica	0·70
Alkaline salts, including sulphate of sodium and chloride of sodium ...	11·36
Sulphate of calcium	10·80
Arsenic	0·05
Organic matter, containing albuminoid ammonia	0.002
Free ammonia	0·012
Nitric acid	0·069
Total solids	27·993

Free carbonic acid not determined.

Throwing out of consideration the Dominique Spring the Vals Waters may be viewed as well defined alkaline waters, the antacid properties of which are chiefly due to carbonate of soda, as evidenced by its marked action on phenol-phtalein on warming—St. Jean being very much of the same character as the others, only much weaker, Madeleine and Precieuse being almost identical in strength and composition, the chalybeate character being well marked in each. St. Jean has been recommended as a table water, and although 1-10 grain of sulphate of sodium is present, it might probably be used with advantage for such a purpose where a slight aperient water is desired particularly, as the accompanying salines are not high. The Vals waters seem to be fairly free from nitrogenous organic matter, but are not waters which are calculated to keep very well for any length of time in the bottled condition. As regards the Dominique water, as it is put forward as an arsenical water, we have endeavoured to give an estimation of the amount of

arsenic present. The previous analyses do not give any estimation of that important ingredient, and although it is attended with some difficulty, as the arsenic seems to be carried down with the deposit, it would appear to contain on an average about 0·05 grain.

Bilin.

This very strong alkaline water is situated at Teplitz (Bohemia). It contains—

	Grains.
Bicarbonate of sodium	261·14
Carbonate of calcium	27·53
Carbonate of magnesium ...	10·66
Bicarbonate of lithium	0·50
Carbonate of protoxide of iron ...	1·00
Sulphate of sodium	51·35
Sulphate of potassium	17·50
Chloride of sodium	26·91
Phosphate of alumina	0·31
Silica	2·40
Nitric acid trace	
Ammonia trace	
Manganese trace	
Total solids	399·30

Free carbonic acid not determined.

Dr. Hassall gives the nitrogenous matter (albumenoid ammonia ?) as being ·022 per 100,000 parts ; we found the sample which we examined remarkably free from albumenoid ammonia, containing nothing like the amount given in his analysis. We are therefore justified in stating that the albumenoid ammonia only amounted to a minute trace.

The skeleton analysis of this water gives in the half-pint (10 *fluid ounces*).

Total Solids.	Antacids.	Purgatives.	Saline
25 grains.	19 grains.	4¼ grains.	1½ grains.

The Bilin water is something like the Vichy waters. It is strong and permanently alkaline—as evidenced by its action on phenol-phtalein. The alkalinity is mainly due to the large quantity of acid carbonate of sodium, the amount of earthy carbonates deposited on boiling being comparatively small. Therefore, the Bilin water may be considered (excepting the Vichy) as the most alkaline or antacid water that we possess. It is slightly more aperient, owing to the sulphate of soda which is present in a somewhat considerable quantity. The chalybeate quality of the water is small, but well marked. It is said that this water is much richer in carbonic acid gas than the Vichy waters, and it is claimed as an "advantage of indisputed superiority." We can hardly see that this applies to the bottled waters, as mineral waters are not bottled under pressure, like the ordinary table, soda and seltzer waters—but its keeping tendency may possibly be improved by the super-saturation of the water at the fountain head. It contains lithium, although the presence of that metal is ignored in Dr. Hassall's analysis, published about eighteen months ago.

Ems.

These celebrated waters, perhaps, owe their renown very much to the situation of the springs, and the mild climate. The waters may be considered as mild alkaline waters, owing their properties chiefly to bicarbonate of sodium. Their aperient action is very slight, and is due to chloride of sodium, with small quantities of Glauber's salts. The Ems waters have been very frequently analysed, and with the usual discordant results, but as they have quite recently been re-examined with great care by Fresenius,

we will content ourselves with giving his analyses of the two principal springs. We have converted his calculations however, into the usual form of grains per gallon, to correspond with our previous analyses.

The Ems waters are rather of a complicated nature.

Krahnchen.

Bicarbonate of sodium ...	148·370
Chloride of sodium ...	70·840
Sulphate of sodium ...	1·370
Sulphate of potassium ...	3·280
Bicarbonate of lime ...	17·240
Bicarbonate of magnesium ...	15·050
Bicarbonate of protoxide of iron ...	0·160
Bicarbonate of magnesium ...	0·072
Bicarbonate of baryta ... / Bicarbonate of strontia ...	0·011
Phosphate of alumina ...	0·032
Silica	3·790
Total solids	260·215
Free carbonic acid	

Skeleton analysis of ½ a pint 10 fluid ounces—

Total Solids.	Antacids.	Purgatives.	Salines.
16¼ grains.	10¾ grains.	¼ grain.	4½ grains.

Kesselbrunnen.

Bicarbonate of soda	151·97
Chloride of sodium	77·70
Sulphate of soda	0·06
Sulphate of potash	3·93
Bicarbonate of lime	18·12
Bicarbonate of magnesia	14·36
Bicarbonate of protoxide of iron ...	0·27
Bicarbonate of manganese	0·04
Bicarbonate of baryta / Barcarbonate of strontia ...	0·03
Phosphate of alumina	0·09
Silica	3·64
Total	270·21
Free carbonic acid cub. inch	67·88

Skeleton analysis of $\frac{1}{2}$ *a pint* (10 *fluid ounces*).

Total Solids.	Antacids.	Salines.	Purgatives.
17 grs.	$11\frac{1}{2}$ grs.	5 grs.	$\frac{1}{4}$ grs.

In giving Fresenius' analyses of the Ems waters we have placed them before the reader just as he states them, but we know that the diads—lime, magnesia, manganese, baryta, and strontia do not exist as bicarbonates, and we have avoided this mode of expression in our analyses, and have always calculated them as $M'' CO^3$. In this instance, however, we have adhered to the analyst, and his mode of expression, premising that if calculated as bicarbonates it would bring out these salts higher than we should give them in calculating an analysis of our own. It is self evident that the carbonic gas which holds these bases in solution would also be estimated a second time as free carbonic acid, and inserted in the analyses twice over.

CHAPTER VI.

THERAPEUTICS OF THE ALKALINE WATERS.

FEW remedies are more interesting than the alkalies, and they have always been the subject of speculation; for simple, as at first sight, some of their effects appear, there are secondary actions about which there is grave doubt. At times they have been so generally lauded as to be constantly prescribed, and then there has come a reaction in which it has been maintained that they are apt to prove injurious. This being the case with regard to the pharmaceutical preparations of the alkalies, we need not be surprised that the popularity of alkaline spas sometimes seems to wax and wane. Still, these springs have from early times maintained a high position, and increase of our therapeutical knowledge seems to extend rather than restrict the indications for their use. It is obvious that alkalies have a great *rôle* to play in practical therapeutics, but this need not blind us to the possibility of their abuse.

Alkaline waters, and for that matter all the potent mineral waters, like other important remedial agents, should be prescribed with care, and patients should not take them except under professional advice. For a like reason medical men should make themselves familiar with the qualities and value of these waters, as well as with those articles of our materia medica which enter into their composition. In any form alkaline remedies a

useful and effectual whenever they are judiciously prescribed, and certainly many mineral waters offer us an agreeable method of employing them.

M. Mialhe, whose researches on this subject extend over many years, has arrived at the conclusion that the alkaline bicarbonates really belong to the class of aliments quite as much as iron, phosphate of lime, chloride of sodium, and other inorganic bodies. As like other salts, the alkaline bicarbonates form a necessary part of the animal economy, as their presence is necessary in a sufficient quantity to maintain certain chemical reactions, he thinks the proportion present in the body cannot vary without giving rise to grave disorder, but that an increase would be much less deleterious than a decrease in their quantity, because an excess is easily removed by the secretions, while there is no way of compensating for an unnatural diminution. This, however, does not satisfy M. Mialhe, who maintains that, in proper doses, the alkaline bicarbonates cannot be injurious, and even in doses far exceeding the usage of our therapeutists, he holds that they are quite inoffensive, and may even be beneficial. He holds, too, and physiological chemistry—of which he is an acknowledged leader—seems scarcely able to dispute the doctrine, that the physical nature of our tissues and vessels presents an insurmountable obstacle to any increase or decrease of the proportion of salts in the blood. Whenever a liquid is introduced into the system containing more of any salt than the blood requires, the excess of that salt escapes by the bowels. Such is the general statement which, although accepted in so many instances, is frequently not admitted in reference to the alkalies, or at least not present to the prescriber's mind, and which M. Mialhe apparently

holds as universally true. According to him we cannot alkalinise ourselves to any extent we may propose, though we may do so within certain limits, and this degree of alkalinisation is, of course, all that is required in therapeutics.

But, if this be so, how about the alkaline cachexia of which so much has been written? If these views be founded on fact, such a condition could never arise as a consequence of the ingestion of alkaline remedies. Accordingly, we are not surprised to find that the author of these views joins MM. Durand-Fardel, Willemin, Boucomont, Petit, and other observers in scepticism as to these ill effects. At Vichy Durand-Fardel has never seen the so-called alkaline cachexia; yet there, if anywhere, unless, indeed, the explanation lie in the kind of alkali, which we shall discuss further on, we might expect it to be occasionally met with. Willemin, so far from admitting the waters of Vichy to be debilitating, claims for them tonic properties under certain conditions. Boucomont, Pupier, and Petit, hold a similar doctrine. In support of this view it has been recorded that as much as 50, 100, 120 grammes of alkaline bicarbonates have been taken per day without doing any injury. We suppose, however, that our readers will regard such experiments as on a par with those made as to the number of tumblers of water that can be swallowed in twenty-four hours. It is well known that enthusiastic hydropathists have drunk excessive quantities, and they are to be congratulated on the activity of their skin and kidneys at the time they made such a strain on their secretory apparatus.

Although the existence of this alkaline cachexia is denied it is admitted that improperly administered, alkalies may

give rise to serious disorders, especially in cases of anæmia, of great debility, or where there is any excess of alkalinity in the system. May this admission serve to convey the differences of opinion that have obtained? All acknowledge that properly administered in suitable cases, alkalies would at least be very unlikely to do mischief, while improperly given in unsuitable cases, they may cause serious disease. At the same time it should be observed, that many of the cases of so-called cachexia have appeared after the administration of large quantities of alkalies for a considerable period during an acute attack of rheumatism. It is difficult to maintain that the case was not suitable, as others exactly similar did so well under the same treatment. It may be thought that in the system of one patient there was an inability to get rid of excess, or that another had some unknown condition affecting the issue, or that the disease had varied; but these are only conjectures, and it is not easy to understand why the same doses, of the same drug, at the like intervals, apparently under like circumstances, should often prove so beneficial and occasionally so disastrous. Here the differences in the effects of the several alkalies ought not to be overlooked. Foreign writers, in speaking of the alkaline treatment, are apt to forget this point. They never omit to cite the mineral waters of Vichy, and the opinions of the residents at that celebrated spa. But now we would add, that soda being the alkali of Vichy water, it may be that the conclusions are drawn from observations, not necessarily applicable to the alkaline treatment of acute rheumatism, which is carried out in most cases with potash, and, as we have said, it is after this disease that injury has been most frequently noticed. There can be no doubt that potash, as a rule, is less easily tolerated than soda. Potash lowers the blood-pressure and the tem-

perature. It seems to possess a direct action on the heart, causing it to beat with less power. The potash salts are some of them very potent cardiac depressors ; indeed, they may be called cardiac poisons. They notably depress all the powers of life, but this may be partially due to some influence on the spinal centre. At any rate, it will be seen that potash and soda differ much in their effects on the system, and although it is to be preferred in certain cases, it is always more likely to do mischief. It is, however, only right to remember the case of the illustrious chemist Therand, who fell into a state of grave cachexia after dosing himself with bicarbonate of soda to the extent of thirty grammes per diem. Few of our readers will be likely to recommend the pushing of the drug to this extent, and we suppose those who deny the danger of alkaline cachexia, will say that such an abuse of the remedy was not rational.

From our estimate of the relative qualities of the alkalies we would suggest that large doses of potash salts should not be continued without great care. This brings us to another point in the treatment of acute rheumatism by alkalies. We believe that the mistake most frequently made is to continue the remedy too long. Suppose it is decided in any given case, that it is desirable to alkalinise the system, then it is better to do so at once, and potash is to be preferred to soda. Large doses may be given for a day or two without fear ; in fact, until the urine is alkaline ; but having reached that point, only just enough potash should be given to maintain the secretion neutral for a few days. After this it may be allowed to be feebly acid. The good to be obtained from the alkali in such cases, has already for the most part been secured. If the justice of these remarks be admitted, their application to the subject in hand will be obvious, from the fact that

alkaline waters are often recommended in chronic rheumatism in which they should be prescribed with circumspection. Probably, the introduction of salicin will largely displace the alkaline treatment of acute rheumatism, but there will also be cases in which the alkalies seem to be indicated, and then they can be tried in the manner we have recommended ; perhaps, too, as preliminary to salicin, salicylic acid, or the salicylates.

To return from this special case to the more general application of alkalies. It is impossible to overlook their simple chemical effect on the primæ viæ. Indeed, for this they are often prescribed, without reference to ulterior action, and in such cases it is that we have most often met with the abuse of this class of remedy. Our readers are however, likely to be alive to this evil, and we may therefore pass on. In the blood the alkalies appear as albuminates, phosphates, and carbonates. The solution of fibrin and albumen is closely connected with their presence, and Liebig thought that carbonate of soda might be regarded as a sort of conveyer of carbonic acid to the lungs. Organic acids and carbo-hydrates and probably some of the more important constituents of the blood are oxidised by these agents, and this accounts for the wasting sometimes seen from their use, especially in fat patients. It would seem not improbable that we can render the blood unusually alkaline, by a careful administration of successive doses, graduated according to the rate of elimination, but the rapidity with which these remedies are carried out of the system, renders it impossible to do this by doses at long intervals. Here is sufficient food for thought to any one who has fallen into mere routine practice. Besides making oxidation more active, alkalies stimulate osmosis. There can be no doubt that, as continual interchanges take place

between the blood and the tissues, we may carry on our work still further by the long continued use of alkalies, and it is probably in this way, rather than in the action in the blood, that the wasting we have alluded to is brought about. When it is advisable to increase tissue-metamorphosis, it may be accomplished in this manner, though the reader will, perhaps, think that there are other more natural methods of reaching this end. Whether such increased metamorphosis leads to the more rapid formation of new tissue is a question which most would answer in the affirmative, but we cannot forget that so desirable a consummation may be sometimes prevented by the very remedy employed. If it impair digestion and assimilation, what other results can ensue? This has happened again and again, but may be avoided by a wise plan of administering the remedy. It is the *proper* use of alkalies, and chiefly of the bicarbonate of soda, that the physicians of Vichy, and other alkaline spas have never seen do any mischief. But their improper use may be fraught with peril, and the late M. Gubler related several instances of alkaline cachexia to the Paris Academy. We have already indicated that this might easily occur, and in doing so, have pointed out the manner in which it is most probably brought about.

Something must be added as to the special indications for administering the waters of this group. Their alkaline property is the most obvious, and to that the chief importance has always been attached. Whether we speak of them as antacids or as agents assisting to maintain the normal alkaline reactions within the body, their use in functional diseases of the alimentary canal is closely related to the employment of soda in other forms. In dyspepsia and diarrhœa this is readily seen, as well as in other disorders

of the stomach and bowels. It is by no means proved that we can increase the normal quantity of soda in the bile, and yet it is believed by some that gall stones have been dissolved in this way. If there be no foundation for this belief, it seems certain that many cases of jaundice—chiefly those depending on catarrh of the cystic duct—have been relieved by alkaline waters. Much the same may be said of functional liver derangements; and competent observers record cases in which palpable enlargement of this organ has diminished during a course of these waters. Such cases are usually treated by the thermal springs, and the influence of the quantities of warm fluid, as well as other circumstances, must not be lost sight of. In lithiasis and in gout these waters are also largely employed, although soda is not considered the most appropriate alkali in these conditions. It is probably by hastening tissue changes that they are efficacious, for the view that they merely neutralise excess of uric acid is insufficient, and this effect is even disputed. In catarrh of mucous membranes these waters are useful. As far as the alimentary membrane is concerned, this may be thought due to the antacid effect, but it can hardly be the case in the respiratory tract, where these waters, and more markedly those which also contain chloride of sodium, prove serviceable. Catarrh of the bladder, and other parts of the genito-urinary tract, may also be treated by these waters, but in such cases caution is to be enjoined. In diabetes alkaline waters must not be given in too large doses, or continued too long at a time. We have refrained from going too deeply into the differences of the several alkalies, because in mineral waters we have practically only to do with soda. The action of bicarbonate of soda, the chief ingredient, is however, some-

times modified by the presence of chloride of sodium, as well as the other constituents, and whether alone or in combination the effect varies with the dose, the degree of concentration of the water, the period of the day when it is taken—a point which resolves itself into the state of the digestion at the time—and, lastly, the temperature at which it is drunk. With regard to this last point something has been said in a former chapter. Here, therefore, it need only be remarked that warmth favours the absorption of the soda, and the warm waters are most in repute when it is desired to affect the fluids of the body, but cold springs are recommended where the local effect on the primæ viæ is aimed at. Some of the bottled waters may be warmed to imitate as far as may be the conditions in which they are taken at the springs. We have now only to note the principal waters of this class.

Vichy is the sovereign of alkaline spas. It possesses both warm and cold springs; its waters are well adapted for bottling, and are, in fact, exported in enormous quantities. Professor Tichborne finds less soda in the bottled waters than might have been supposed from previous analyses; but still, the quantity is so great that Vichy retains its pre-eminence as the strongest alkaline spa. The number and varying qualities of its springs enable those skilled in their use to rely entirely upon them when mineral waters of a powerful alkaline nature are required. It is always to be remembered that these waters are potent medicines.

The *Grande grille* is a hot spring, temp. 105 deg. Fahr., and perhaps more used than any on the spot. It is specially used in diseases of the abdominal viscera, in the cachexia induced by residence in hot climates, in obesity, and whenever it is desired to stimulate absorp-

tion. In some cases of biliary calculi Vichy is useful. Diseases of the spleen are treated, but with much less benefit. Patients with gravel or other urinary affections resort in great numbers to Vichy. In gout, the *Celestins* spring, which is cold (temp. 58 deg. Fahr.), and by far the most pleasant to drink, is in most repute. It bears exportation well, and, as a naturally cold water, seems well adapted for bottling. The writer has prescribed it for many years. The *Hauterive* has recently replaced it to a considerable extent. We may, however, observe that all the springs possess the same general character, that the distinctions offered are by no means absolute, that one may usually replace the other, that the differences observed at the springs are mostly due to the various temperatures, and that, so far as regards the exported waters, all may be considered of equal value. In disorders of the stomach it is unnecessary to point out the indications for alkalies. In diabetes Vichy has been of great service, but the treatment is usually carried out at the spa. A season has often been followed by excellent results, and, during the intervals between their visits, patient may at intervals drink the bottled waters, with the circumspection indicated above. As the writer has previously published a pamphlet (*a*) on these waters which has passed through four editions, he need say no more on the subject here.

Vals.—It has been stated in some quarters that Vals furnishes the most concentrated of all the alkaline waters. A reference to Prof. Tichborne's analyses (p. 85-8) is sufficient to dispose of this assertion which

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(*a*) "A Visit to Vichy, with an Account of its Thermal Springs. &c.' By Prosser James, M.D.

was perhaps founded on M. Ossian Henry's analysis. That chemist found a much larger proportion of soda present, but whatever may have been the amount in the water when he examined it at the springs, the only indications for prescribing the bottled waters are furnished by their chemical qualities as now imported. The highest proportion of carbonate of soda found by Prof. Tichborne was 13·27 grains in ten fluid ounces, while Vichy yielded 24 grains. This is in accord with our clinical experience for we have never considered Vals as strong as was represented. It is assuredly a less powerful antacid than Vichy. Still these waters are useful agents, and may be employed in a similar way to those of Vichy, bearing in mind their relative strength, a point now decisively settled. The Précieuse and Madeleine springs are regarded as more tonic, inasmuch as they contain a fraction more iron. It is, however, scarcely appropriate to apply the term chalybeate to such waters. The claim of the Dominique spring to be termed arsenical will be spoken of hereafter. The St. Jean is so weak that it is sometimes spoken of as a table water, but it contains five grains of antacids in the half-pint, and may therefore claim to be medicinal. It is useful when a weak alkaline water is required, and therefore is to be specially distinguished from the other Vals waters.

Bilin water has been lately imported, and is strongly alkaline, as much so, in fact, as the weakest spring of Vichy, but much less so than the others. The amount of earthy carbonates is also small, so that the water is not "heavy" on the stomach. It is a very good useful member of the group of strong alkaline waters.

Ems.—In the waters of Ems the proportion of carbonate of soda is much less, but its action is re-enforced as

well as modified by the chloride of sodium which is present in sufficient amount to give Ems a claim to be included in a group of waters containing the two salts. We have already shown that the chloride is a corrigent as well as a most useful adjunct. It stimulates the stomach and bowels, increasing the secretion of the mucous membrane, and promoting tissue metamorphosis. It is chiefly due to the combined effects of the two salts that Ems retains its celebrity, unless we are to attribute a greater effect to the climate and surroundings when patients resort to the spa. In catarrh of the stomach and other conditions requiring an alkaline water of less strength than Vichy, but more stimulating in its nature, Ems may be tried. In catarrh of the respiratory mucous membrane, Ems also long enjoyed considerable reputation, but in laryngeal and bronchial cases, we venture to assert that it is only seldom that the depressing and admittedly rather damp climate of this valley, with its mid-day heat, and evening and morning mists, should be recommended. It was at one time extolled for consumption, but all have now given up recommending it in that disease. The fame of the "Bubenquelle" for sterility has quite passed away, but the place is much resorted to for the treatment of diseases of women, when a course of baths and alkaline salt waters are desirable. The bottled waters are not so much employed in this country as they might be, considering their mildness and the indications we have given for their use.

CHAPTER VII.

CHEMICAL CHARACTERISTICS OF ARSENICAL WATERS.

An analysis of the water of the St. Dominique well, at Vals, has already been given at p. 88, showing that it contains only 0·05 of arsenic, although sometimes regarded as an arsenical water.

La Bourboule—Source Choussy.

Arsenical, but strongly alkaline, are the Bourboule springs—Puy du Dome, France. There are two principal springs, Choussy and Perrière, but we have only met with the first-named water. This source (Choussy) rises at a high temperature, 108 Faht., from two openings. Thènard first announced the fact that this water contained large quantities of arsenic, and states that it exists as arsenious acid, or as neutral arsenite of soda. The water is compared with Ems. The proprietors say, "Ems water and that of La Bourboule-Choussy resemble each other very closely, with the exception of arsenic, which is only found in the waters of La Bourboule-Choussy.

It contains—

Bicarbonate of sodium	100·22
Carbonate of calcium	11·33
Chloride of sodium	221·00
Chloride of potassium	4·12
Chloride of magnesia	2·54
Arsenious acid	0·80
Sulphate of potassium	9·20
Ferric oxide	0·37
Silica	1·99
Alumina (trace)	
Lithium (trace)	
Ammonia (trace)	
Total solids	351·57 grs.

Free ammonia not determined.

Skeleton analysis of ½ *a pint* (10 *fluid ounces.*)

Total Solids.	Salines.	Antacids.	Purgatives.
22 grs.	14¼ grs.	·7 grs.	¼ gr.

Arsenic ... ... ·05

There is no doubt that the arsenic exists in the water as arsenious acid, or rather we should say as arsenite of sodium, it therefore differs in this respect from t Dominique, or the arsenical Vals water. It is another example that most of the arsenical waters are strongl alkaline. This is much more likely to be the case when the arsenic is in the lower state of oxidation. When it is found associated with the nitrates, or in a thoroughly oxidised water we find it generally existing as arsenic acid. *Vide* Dominique spring. The relative therapeutic value of arsenious acid ($As^2 O^3$) and arsenic acid ($As^2 O^5$) is still a moot question. The Choussy seems to be a very pure water.

Court St. Etienne.

Not a very great distance from the historic ground of Waterloo, some arsenical waters were discovered in 1878, at Court St. Etienne. The Court St. Etienne water can-

not be considered as purgative, but it is stated that it is one of the strongest and most permanent of the arsenical waters.

It has been analysed by Prof. De Wilde, of the University of Bruxelles, whose analysis runs as follows :—

Silica	0.0086	
Ferric oxide	0·0090	
Lime	0·0728	
Magnesia...	0·0061	
Potash and soda...	0·0193	
Lithia	trace	
Sulphuric acid	0·0776	
Carbonic acid	0·0110	
Chlorine	0·0176	
Nitric acid	0·0346	
Arsenic acid	0·0097	
Organic matter and loss ...	0·0259	
	———	grm.
Total ...	0·2922	
Less oxygen corresponding to Chlorine	0·0039	
Total per litre	0·2883	grm.

We do not find this water exactly the same as the above, and would prefer to try and associate the acids and bases together. The specimen we examined gave on analysis—

Chloride of sodium	1·80	
Chloride of calcium	0·34	
Nitrate of calcium	3·03	
Sulphate of calcium	6·26	
Sulphate of potassium	0·39	
Iron (ferric oxide)	0·35	
Silica	0·60	
Carbonate of calcium	2·07	
Carbonate of magnesium	1·03	
Organic matter and loss	0·80	
Lithia	trace	
Arsenic ($As_2 O_5$) 0·5 = Arseniate of sodium	0·83	
Total solids ...	17·50	grs.

Free carbonic acid gas not determined.

Skeleton Analysis of Half-a-pint (10 *fluid ounces.*)

Total Solids.	Antacids.	Arseniate of Sodium.	Salines.
1, 1-10th gr.	2-10ths gr.	·05	1-3rd gr.

The Court St. Etienne spring is evidently a very valuable water of a new character. It might, we should say, be indulged in rather freely, because the total solids are under 18 grains per gallon ; but, at the same time, it must be borne in mind that over 4½ per cent. of those solids consist of arseniate of soda. That the arsenic exists in the water as the higher oxide of arsenic there can be little doubt, and in this respect it differs materially from such waters as Vichy, in which the arsenic is present as $As_2 O_3$.

The water is perfectly neutral to phenol-pthalein, owing to the fact of its antacids being only carbonates of alkaline earths. It contains no alkaline carbonates. It is also perfectly neutral to tropeoline, and seems to possess great permanent properties. It also seems to be quite free from nitrogenous organic matter.

CHAPTER VIII.

THERAPEUTICS OF ARSENICAL WATERS.

Some years ago no little sensation was caused by the discovery of traces of arsenic in several mineral waters. Many at once concluded that the full therapeutic value of arsenic could be obtained by drinking such waters, and in the case of spas already in high repute, no small share of their virtues was attributed to the newly-discovered ingredient. It was, however, very soon found that arsenic was far more generally distributed than had been supposed, and so many spas were able to boast of its presence that any specific effect was seen to be doubtful. Moreover, in all cases only minute quantities of the element were detected in the water—mere traces, certainly not enough to enable us to choose such media for the administration of ordinary doses of arsenic ; in most cases it would require from half-a-gallon to a gallon of the mineral waters to be imbibed daily in order to obtain a moderate therapeutical dose. Further, this medicament was associated with much larger quantities of other substances to which it was only natural to attribute the chief effects of the waters. The arsenic was most frequently found in alkaline waters, and in such cases could only be regarded as an adjunct to the soda. Accordingly, few now insist on mere traces of arsenic as characteristic of such waters. Nevertheless, there are

two or three spas which have obtained a certain repute for their so-called arsenical springs. Among these the St. Dominique, of Vals, a weaker alkaline spring than the others at the same place, has been pushed. Professor Tichborne finds it only contains 0·05 grains per gallon. Some of the success of Mont Dore has also been attributed to the minute quantity of arsenic found in the waters. But the chief arsenical spa up to this time has been La Bourboule, where there are three alkaline springs, containing a good deal of chloride of sodium. In one of these Professor Tichborne finds ·05 grain in ten ounces of the water, which is present in the form of arsenite of sodium. (See his analysis, p. 106). Another water he has analysed is that of Court St. Etienne, which differs much from others, as it contains only 18 grains of solid substances in a gallon, and thus the arsenic can be taken almost pure. The amount present is ·05 gr. in ten ounces, and it is present as arseniate of soda. This water is, then, not an alkaline one, and what effects it may be found to have will be fairly attributed to the arseniate of soda.

The indications for the use of arsenic are sufficiently distinct, and if the medicine be present in sufficient quantities in any mineral waters, advantage can be taken of them to provide an additional mode of administration. If an alkali be at the same time indicated La Bourboule may be given ; if otherwise, a trial may be made of Court St. Etienne. In either case it will naturally occur to the reader that not seldom the use of the pharmacopœial preparations of arsenic may be equally useful and more reliable. If need be they may be reinforced by alkaline and ther mineral waters.

CHAPTER IX.

TABLE WATERS.

We have now to deal with an important body of waters. They include those which have generally been classed under distinct heads, namely—saline (waters owing their chief efficacy to salt) faintly alkaline waters, and indifferent waters. Now, we prefer to class all these waters under one head—it is immaterial to us what the exact analysis may give ; it is evident that as regards classification we must consider them from the point of view of their application, the justification of the application being determined by the analysis. If they are used as a table water, or a food product—they are certainly equally important, we may say *more* important than other waters, because of the very large quantities consumed.

Seltzer.

The most important of table waters we give first. Advertisements may have done a great deal, quality has done something, but no water has been able to displace Seltzer water as regards its hold on the public mind, and its position as a natural table water. It is the one which has been the type of artificial table waters. The consideration also of Seltzer water will justify us in a system for the first time adopted in these articles of keeping the salines, such as chloride of sodium, distinct in our classification from the strong purgatives, such as sulphate of

sodium. It has been pointed out in the therapeutics of our work, that even water itself may be viewed as an aperient under certain circumstances. It is not practically so, however, when drank at the table with our meals, and the same may be said of salines, such as chloride of sodium. We could have no better illustration of this than the very general use of Seltzer water, which, if it acted at all energetically as an aperient, would not be used as a table water. These remarks must be always borne in mind in considering the analyses of table waters; the presence of rather large quantities of chloride of sodium is no detriment, providing the sulphates of magnesia and soda are low. The seltzer spring contains nearly 200 grains of chloride of sodium, but very little sulphate of sodium, and no sulphate of magnesium.

It is, perhaps, not too much to say that the most celebrated waters, perhaps in the world, are those obtained at the small post-town called Selters, a short distance from Schwalbach. Although we have never been at that town, we think we are justified in stating that the spring or springs are not used as baths, and that it is entirely consumed in bottles for home and export consumption. Murray, in 1876, stated that a million and a-half of bottles were exported annually, and that the quantity was increasing. We can readily believe that the consumption of this water has been even further increased owing to the extensive use of it on the table. Although, strictly, a mild saline alkaline water in its natural state, its piquant flavour is increased by the addition of salt, which brings its solid ingredients up to 279 grains; the added salt is nearly one-half of the entire solids.

Seltzer.

Bicarbonate of sodium	47·07
Carbonate of calcium	21·91
Carbonate of magnesium	21·51
Chloride of magnesium	15·04
Protocarbonate of iron	1·50
Carbonate of manganese	0·02
Chloride of sodium	162·44
Chloride of potassium	2·39
Sulphate of sodium	2·13
Phosphate of calcium	trace
Phosphate of sodium	3·13
Fluorine	·01
Bromine	trace
Nitrate of calcium	0·13
Silica	2·05
Free ammonia	0·037
Nitrogenous organic matter (none)	
Total solids	279·30 grs.

Carbonic acid not determined.

The Skeleton analysis of ½ *a-pint or* 10 *oz. fluid—gave*

Solids.	Salines.	Antacids.	Purgatives.
17¼ grs.	10¼ grs.	5½ grs.	1 gr.

The antacid properties of this water are largely due to the alkaline earths, and the consequence is that it does not present a very marked alkaline reaction with phenol phtalein, even after prolonged boiling. Still, it does exhibit a slight alkaline reaction, particularly if warmed. The water, as examined by us, differs very considerably from the published analysis, more particularly as regards the smaller amount of alkaline carbonates, and the presence of chloride of magnesium, which is ignored in the other analyses.

We have already referred to the difference in the composition shown by the analysis published by us and those previously given. We subjoin a copy of Kastner's analysis, and the discrepancies pointed out will be readily perceived.

Seltzer according to Kastner.

	Grs.
Bicarbonate of soda	9·7741
Chloride of sodium	17·2285
Chloride of potassium	0·2890
Sulphate of soda	0·2615
Phosphate of lime	0·0004
Phosphate of alumina	0·0002
Phosphate of soda	0·2615
Fluoride of calcium	0·0016
Bicarbonate of lime	2·6678
Bicarbonate of magnesia	2·5586
Bicarbonate of protoxide of iron ...	0·1088
Bicarbonate of manganese	0·0032
Bromide of sodium	0·0002
Silica	0·2500

The most important discrepancy here is the non-appearance of any soluble salt of magnesium except the carbonate. This is decidedly wrong as applied to the bottled waters, as evidenced by the fact that, on the evaporation of the Seltzer water to dryness in a capsule, and on re-solution in water and filtering, the greater part of the magnesia is found in the filtrate; had it existed entirely as carbonate, it would have been practically left in the insoluble form on the filter. The larger portion of the magnesia is evidently present as chloride, and this fact accounts for the pleasant sweet taste which the Seltzer ater possesses. The chloride of sodium adds to this a piquant flavour which is very grateful. It is not generally

known that the magnesium bitter taste is peculiar to sulphate of magnesium. It is that salt which has induced the name "bitter wasser" to be applied to so many of the Continental purgative waters. The bitterness may be perceived in a solution of carbonate of magnesia in carbonic acid gas, or in a few of the other salts in a more or less degree, but not so in the chloride of magnesium. (*a*)

The discrepancy observed in the analysis may be accounted for by a remark made by Messrs. Ingram and Royle, the well-known mineral water importers. They say "that the water, as it flows from the spring contains a small quantity of iron, and, when bottled in glass bottles, is liable to discolour wine or brandy when mixed with it" (from the tannic acid present in the wine forming tannate of iron). "This disadvantage, which applies not only to Seltzer, but all waters of a chalybeate character, is obviated when the water is bottled in earthen jars, as a small quantity of common salt is placed in the jar, which causes the iron to deposit. The omission of this precaution, or carelessness in performing it, which sometimes occurs, explains the misapprehension."

We cannot see that it explains anything except the fact that the amount of the chlorides, as compared with the original spring, is largely increased. Nor can we see what difference the bottling in stoneware, as compared with glass, has to say to the precipitation of this iron, without some of the lime or other salts in the imperfectly glazed

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(*a*) Fresenius states that "the soluble salts of magnesium have a nauseous bitter taste," and this seems to have been accepted generally without further investigation. Anyone who tries a solution of chloride of magnesium will find that it is quite sweet, and this description applies to many other salts of magnesium.

bottles act upon the water, and cause a precipitation. If such were the case it would be a very strong argument for discarding the earthen bottles. We are rather inclined to think that the real object in using these bottles is to hide any deposit which might fall, and which would look ugly in the glass bottles.

In describing the Vichy waters we dwelt at some length upon the bottling of the waters, and as the Seltzer waters represent a typical system of bottling in which stoneware jars are used we will devote a small space to the description of the bottling process as carried on at Neider Selters, premising that the account is chiefly taken from an amusing book, which, as regards its scientific and other information, is rather out of date—*i. e.*, "Bubbles from the Brunnens of Nassau." The profitable spring, which was the property of the Duke of Nassau, was placed at the disposal of the people after a certain number of hours had been spent in bottling for stock. The earthen bottles or jars are supplied from various manufacturers, and are therefore uncertain as regards their quality. A number of young girls carry thirty-four of them at a time to an immense trough, which is kept constantly full by a large fountain-pipe of clear fresh water. The bottles, on arriving, were here filled brimful (as the writer conceived) for the purpose of washing, and were then ranged in ranks of a hundred each, there being ten rows of seventy bottles. Next morning the writer perceived that about one-third of these bottles were in a mutilated state, their noses lying by their side, supported by the adjoining bottles. "What could possibly have been the cause of the fatal disaster which, in one single night, had so dreadfully disfigured them, I am," says the writer, "totally at a loss to imagine." On asking for an explanation he was informed that, being

supplied from different manufacturers, they are, after filling brimful, left for the night. The officer visits them next morning—whose wand of office is a thin, long-handled, little hammer—when he walks along each line, and the instant he sees a bottle not brimful, without listening to any long winded argument, he at once decides that there shall be no mistake, and thus, at one tap or blow of the hammer, off goes the head. The bottle must either contain a crack, be porous, or it will retain the water twelve hours at its original level. After this performance the men reverse the full bottles in the ranks, every broken bottle being thrown away. By this means the bottles undergo a process of washing after soaking for twelve hours, and to a certain extent this remedies the objections which we are now about to raise to the stone bottle.

Everyone knows that even in well-glazed stone or earthenware bottles there is a certain amount of porosity. Now, not only does this allow the gas to get in, but soluble constituents of the clay are rendered up to the water. Ems, Pullna, and other waters, are still put into these old-fashioned stone bottles, and we think it is quite time the practice were discontinued in favour of glass bottles. As the bottles are made of the roughest materials, the vessel would be most objectionable were it not for the method provided at Selters of soaking them. However, this is not infallible, as is proved by a bottle before the writer now, which, although still retaining the original cork, and being perfectly free from any crack, has lost half its contents after standing for six months in an upright position.

Taunus.

This water is derived from a well-known spring, situated at a short distance from Frankfort-on-the-Maine.

As it has been lately analysed by Taylor, we give his analysis, only converting the original figures into grains per gallon for the sake of comparison.

Chloride of sodium	180·04
Chloride of potassium	18·90
Carbonate of calcium	95·90
Carbonate of magnesium	12·32
Carbonate of sodium	1·40
Sulphate of calcium	4·06
Silica	traces
Alumina	traces
Phosphate of calcium	traces
Total solids	312·62
Carbonic acid (given as compressed) ...	202·58
Carbonic acid (in solution)	121·45

We have ourselves examined this water for nitrogenous organic matter, and find it fairly free therefrom. It will be seen that in it the alkalinity is greatly due to the carbonates of the alkaline earths, and would be useful where bone constituents are wanting.

The skeleton analysis of 10 *ounces* ($\frac{1}{2}$ *pint*), *gave*

Total Solids.	Antacids.	Salines.	Purgatives.
19$\frac{1}{2}$ grs.	6$\frac{3}{4}$ grs.	12$\frac{1}{2}$ grs.	None.

This water is peculiar, although pure ; it is calcareous and non-purgative, and therefore should only be adopted under medical advice as a table-water.

Harzer Water.

We are at a loss to find out much information about

the source of this water. It, however, seems to be making ground. It contains—

Bicarbonate of sodium	10·12
Carbonate of calcium	17·13
Carbonate of magnesium	3·62
Chloride of sodium	49·08
Chloride of potassium	0·28
Sulphate of sodium	1·13
Silica	0·12
Lithia (minute trace)	0·01
Total solids	81·49

Free carbonic acid, not determined.

Skeleton analysis of 10 *fluid ounces,* ½ *pint.*

Total Solids.	Antacids.	Salines.	Purgatives.
5, 1-10th grs.	2 grs.	3 grs.	·07 grs.

It will be observed that this water is one in which the sodium saline predominates with a well-marked alkalinity, due to bicarbonate of sodium, as evidenced by its action in phenol-phtalein. At the same time it is a comparatively light table water. It is quite pure as regards nitrogenous organic matter. The taste of this water is pleasant ; in fact, we may say that it belongs to those waters which possess a special piquant flavour. It is stated that this water has a large sale on the Continent, and that the consumption was 1,000,000 bottles in 1879, and has probably largely increased. The ingredients in this water are very nicely balanced. It is a strongly effervescing water.

Apollinaris.

Apollinaris water, according to the original analysis,

is stated to contain 178 grains of solids per imperial gallon, 88 grains of which are carbonate of sodium. We find that this water is a little stronger than this, giving 258 grains, when thoroughly dried, at 212° F.

It contains—

Bicarbonate of sodium	106·21
Chloride of sodium	50·23
Sulphate of sodium	24·02
Phosphate of sodium	trace
Sulphate of potassium	1·41
Carbonate of magnesium	45·00
Carbonate of calcium	28·80
Ferric oxide	1·00
Alumina	0·80
Lithium	minute trace
Silica	1·21
Free ammonia	trace
Nitric acid	trace
Total solids, dried at 212 ...	258·68

Free carbonic acid not determined.

Skeleton analysis of 10 *fluid ounces,* ½ *a pint.*

Solids.	Antacids.	Salines.	Purgatives.
16·1-10th grs.	11¼ grs.	3·1-10th grs.	1½ grs.

The proprietors make a great point of contrasting this water with seltzer water, as it possesses similar constituents, *but combined in happier proportions* by the chemistry of nature. The italics are so in the circular.

The strong points about Apollinaris water are first, its freedom from organic impurities; secondly, its pleasant aërated character, and the fact that if the source of supply

is so copious, it will probably be fairly constant in composition.

The original analysis runs thus (marked old analysis), when calculated to the imperial gallon,

Carbonate of soda	87·99	
Chloride of sodium	32·62	
Sulphate of soda	21·00	
Phosphate of soda		
Salts of potash		
Carbonate of magnesium	30·94	
Carbonate of lime	4·13	
Oxide of iron and alumina	1·40	
Silicic acid	0·56	
Total	178·64	grs.
Free and semi-combined carbonic acid	27·75	
Combined carbonic acid	8·7	

Apollinaris Water, although comparatively new, is extensively used in this country, owing to the mode in which it has been advertised, and also to undoubted merits of its own.

It flows, according to the statement of the proprietors, from a spring in the valley of Ahr, near Neuenahr, in Germany. It has been stated, from personal inspection, that from the well issues a supply of mineral water amounting to 6,000 large bottles per hour, equal to forty millions per annum. None other than the natural gas is said to be used in charging the bottles and jars. In this respect the Apollinaris Brunnen was one of the first natural aërated springs put upon the market. It springs, according to the circulars, from a deep, rocky source.

Again, the directors say, "Apollinaris, being a *pure natural product*, possesses many obvious advantages as a table beverage over ordinary artificial aërated waters." We must demur to such a theory, because there are hundreds of mineral and other *pure natural* waters which are perfectly unfit for table use.

There seems to be two qualities of Apollinaris water in the market—1st. Bottled under single pressure; 2nd. Bottled under double pressure. We presume this first water is bottled under the pressure obtainable at the surface.

In speaking of the amount of carbonic acid present in this water, and the peculiar mode in which the above-quoted aëration is expressed, we must dwell for a moment upon the subject of the genuineness of the Apollinaris water, as it very materially concerns a series of articles like the present, which have been constructed with a view of determining the merits as well as the *bonâ fides* of, such preparations. It is no secret that the genuineness of Apollinaris water has been disputed. In other words, it has been stated that Apollinaris is a made-up water, being, in fact, not only artificially aërated, but more or less added to as regards its constituents. If so, it would be our bounden duty to expose such imposition; whilst, if it is not so, we have every right to try and clear away any mystery. We are of opinion that the expressions quoted have led to a misapprehension as regards this point. We refer to "bottled under single and double pressure."

The amount of carbonic acid stated in the analyses (see original analysis) corresponds to the amount of free and combined carbonic acid as found at the mouth of the spring,—*i.e.*, on the surface of the water. The water,

in the depth of the earth, contains a larger quantity of carbonic acid, corresponding, according to a well-known scientific rule, to the height of the column of water pressing upon it.

The slight difference in favour of the carbonic acid of the water in glass bottles as compared with those in stone jugs is owing to the fact that the transparent bottle can be filled with water up to the necessary height, and immediately corked without the admission of any air ; while a wooden plug has for a moment to be inserted into the stone jug, in order to expel a sufficient quantity of water to allow the jug to be corked without bursting. We have steadily set our faces against the use of stoneware jugs for mineral waters, believing that the undoubted superiority of glass in every respect, both as regards the keeping of the water, its freedom from earthly impurities, and other causes, too numerous to now recapitulate, are quite sufficient to do away with this relic of barbarism. The great inducement (*i.e.*, the dearness of glass) has now gone. It is, therefore, with some surprise that we see a large and important company encouraging such a mistake as to cater for the old-fashioned prejudices of the ignorant.

As regards the genuineness of the Apollinaris water there can be little doubt. The natural carbonic acid gas, being used for charging the bottles, and producing a water which, when bottled, exerts a considerable pressure, is one of the two reasons which have given rise to the statement. The water seems to be obtained at a depth of seventy feet below the surface of the earth, and, calculating from the quantity of free carbonic acid gas in the water at the outflow of the spring, it follows, in accordance with the physical laws, that the water, where drawn, must be as much supersaturated with carbonic acid as if subjected to a

pressure of more than two additional atmospheres. Considering that the spring, at its outflow, has a temperature of 70° Fahr., its origin, on the basis of the so-called Henry's principle, must be supposed to exist at a depth of 920 feet. Here it would have twenty-nine times the quantity of carbonic acid gas that the water shows at its outflows.

"These remarks will explain the fact of enormous exhalations of carbonic acid at the spring, which are so great that in the absence of strong winds it is found impossible to descend the stairs leading to the pit surrounding the spring further than within eight to nine feet above the pavement." "When the water rises to the surface, the gas escapes from the water; but as the spring is covered by a metal cylinder, the gas is carried into a hermetically-closed reservoir, from whence it is forced again into the water, under such pressure as will represent the pressure exerted at the depth from whence the water is taken." If this is a correct explanation, such a procedure is perfectly legitimate, and thus disposes of the statement of its being similar to an artificially aërated water.

Another reason for the statement that Apollinaris water is artificial is the small addition of chloride of sodium, which is openly acknowledged. This is the statement put forward by the company :—"A small quantity of chloride of sodium (never exceeding 1 in 1,000 parts) is added to the water, or the corks are soaked in a solution of salt It had been noticed that when mineral waters had been bottled for a length of time sulphuretted hydrogen was developed, owing to the reducing action of the cork on the small amount of sulphate of soda contained in such waters. As a preventive, Professor G. Bischoff's proposal to make the aforesaid addition was acted upon.

Adelheidsquelle.

A Bavarian spring situated near Heilbrunn ; is largely imported. It has been analysed by Pettenkofer, whose analysis we give, calculated to grains per imperial gallon :

	Grains.
Chloride of sodium	380·68
Bromide of sodium	3·67
Iodide of sodium	2·19
Chloride of potassium	0·20
Sulphate of sodium	0·48
Carbonate of sodium	62·16
Carbonate of calcium...	5·84
Carbonate of magnesium	1·44
Carbonate of iron	0·72
Alumina	1·42
Silica	1·47
Phosphate of calcium, trace	
Organic matter	1·60
Total	461·87

Carbonic acid not determined.

Skeleton analysis of half-a-pint, or 10 *fluid ounces :—*

Solids.	Salines.	Antacids.	Purgatives.
28·8¾ grs.	23·8¾ grs.	4½ grs.	·03 grs.

The Adelheidsquelle water is a very strong saline water, with a well-marked alkaline character, due to the carbonate of sodium. It contains comparatively little lime. It also possesses the peculiarity of containing a considerable quantity of alkaline iodides and bromides ; therefore, will probably be used more as a medical water than as a table water. It has, however, a composition based upon the lines of the table waters, and is therefore placed amongst them.

Gerolstein.

At a short distance from the ruins of Castle Casselburg, between the rivers Kyll and Moselle, is an artesian well, called the Schlossbrunnen Gerolstein.

This artesian well is sunk to a considerable depth in a bed of limestone and slate. The country would appear to be a district of extinct volcanic craters, and it is probable that the Schlossbrunnen Gerolstein derives, as stated in the circulars, its chemical components (the saline and alkaline ingredients) from layers of basalt and porphyry. It is stated that this water being obtained by sinking the artesian well in the Eifel volcanic mountains is perfectly free from all organic matter, or impurity. The circular goes on to say that unlike most mineral waters it is wholly impregnated with its own natural gas, or carbonic acid which rises in volumes from the shaft and rocky fissures. "The Gerolstein water is not tampered with in any way, but is delivered in the same state exactly as it flows from the spring." Although the springs are reputed as being valuable medicinal springs from the 13th and 14th century the artesian well was not opened with a view to its commercial dissemination until the year 1876, we may say that although this water is old in local reputation, it is not so well known as many others in its bottled form.

Although it is not many years since this water has been introduced into this country, it would seem that it has received a considerable amount of royal and high-class support. This means very little. Perhaps no class is as sensitive to a name as the upper classes. Let a company get hold of a good name, and the upper circle follows like a flock of sheep Our remarks, however, do not apply to the Gerolstein water, and they would be quite out of place were it not for the extensive manner in which such a system of advertising is used in the mineral water world.

The Gerolstein water is comparatively a mild antacid

water, giving no permanent alkaline reaction until boiled some time with phenol-phtalien, showing that the alkalinity is nearly equally distributed between alkaline bicarbonates and the carbonates of the alkaline earths. It is remarkably pure, and stood those searching tests for the presence of nitrates and nitrites, diphenylamine, and metaphenylein diamine. It is quite free from nitrogenous organic matter. It has been already stated that the Gerolstein Company only charge this water (which is strongly aerated) with the natural carbonic acid gas obtained from the spring; and they invite inspection of the spring and works. One of the recommendations of the Gerolstein water is that, combined with great purity, from the small amount of solids contained therein, it may be indulged in freely; at the same time, it must be always borne in mind that its action will be slightly aperient, but this to many thousands, will be hailed as a grateful characteristic of Gerolstein.

Gerolstein water contains—

Bicarbonate of sodium	72·71
Carbonate of lithium	·10
Carbonate of calcium	42·6
Carbonate of barium, trace	
Carbonate of magnesium	24·2
Carbonate of iron (ferrous carbonate)	0·10
Carbonate of manganese, trace	
Sulphate of potassium	0·20
Sulphate of sodium	8·21
Chloride of sodium	12·26
Bromide of sodium	0·11
Iodine, trace	
Phosphoric acid	0·02
Silica	3·03
	163·54

Free carbonic acid not determined.

Skeleton Analysis of Half-a-pint (10 *Fluid Ounces*).

Total Solids.	Antacids.	Salines.	Purgatives.
$10\frac{1}{4}$ grs.	$8\frac{3}{4}$ grs.	$\frac{3}{4}$ gr.	$\frac{1}{2}$ gr.

Bellthal.

A spring, in the valley of Moselle, is recommended as a light table water.

It contains in the gallon—

Bicarbonate of sodium	22·54
Bicarbonate of potassium	5·83
Carbonate of magnesium	13·93
Carbonate of calcium	40·13
Chloride of sodium	1·53
Sulphate of sodium	1·10
Nitrate of sodium	0·23
Carbonate of iron	0·12
Carbonate of manganese	0·03
Ammonia trace	
Phosphate of calcium	0·01
Alumina	0·02
Silica	0·30
Total solids	85·77 grains.

Free carbonic acid not determined.

Skeleton Analysis of Half-a-pint (10 *oz. fluid*).

Total Solids.	Antacids.	Salines.	Purgatives.
$5\frac{1}{3}$ grs.	5 grs.	1-10th gr.	1-10th gr.

We cannot recommend this water. It is of an antacid nature, chiefly owing this property to the presence of a rather large proportion of alkaline earths, whilst the presence of ammonia, nitric acid, and phosphates being so well-marked is an objection to its general use as a table water. It deposits on standing a slight sediment in the bottle, which chiefly consists of iron.

Wilhelms' Quelle.

This is another of the aërated mineral waters of the same character as those lately considered. The spring is situated in a beautiful district, mountainous in the extreme. Kronberg is the nearest point. The Sauerborn, or mineral spring, gives rise to the name of the valley of Sauerborn It is an isolated but beautiful spot. The Wilhelms' Quelle was known as far back as the Sixteenth Century, and at that period was in great request according to the account of the proprietors. "Perchance, when summer heat held sway, the lonely solitude of the spring might be broken by the inhabitants of Kronberg, who came to fill their pitchers at the source"—so runs the description. It is mentioned by Tabernae Montanus, a celebrated natural philosopher of his day, in a work published in 1584, at Worms, viz., "The Water Treasury." The spring was first enclosed in 1618. This enclosure was renewed in 1790, and finally improved and rebuilt in 1878. The valley is covered with springs, which gush forth in all directions. Many of these springs, however, differ much in composition ; for instance, there is one strongly chalybeate, and another which is described as being "saturated with salt." The circular issued with this water contains a curious statement. It says, "This is the only table water which contains iron in the peculiar form of the protoxide, being exactly in the same form as the iron contained in the human blood." We should be inclined to say that in mineral waters the iron is invariably in the proto- or ferrous form when in the spring, but naturally becomes oxidised by age. This does not, however, occur so readily in the waters, which are decidedly aërated by carbonic acid gas.

A number of analyses of this water have been made, including one made by Fresenius in 1878. This analysis

seems very exhaustive, and is stated to have been partially performed at the laboratory of Wiesbaden. Another has been performed by Prof. Attfield, of London. We give the analysis in this book as based upon their analyses. In Fresenius's report he goes into minute details which the larger quantity of water at his disposal enabled him to determine, but to them we have added a few points from observations made by our own examinations. It contains in the gallon—

Bicarbonate of sodium	5·49
Bicarbonate of lithium	0·30
Carbonate of barium	0·24
Carbonate of strontium	0·02
Carbonate of calcium	29·54
Carbonate of magnesium	6·75
Chloride of sodium	117·53
Chloride of potassium	2·48
Bromide of sodium	0·04
Iodide of sodium	Trace
Sulphate of sodium	1·57
Phosphate of sodium	0·06
Carbonate of protoxide of iron ...	2·00
Carbonate of magnesium	2·00
Silica	7·00
Ammonia	Trace
Total	175·02 grains.

Free carbonic acid gas not determined.

Skeleton analysis of half a pint (10 *oz. fluid*).

Total Solids.	Salines.	Antacids.	Purgatives.
$10\frac{3}{4}$ grs.	7 grs.	$2\frac{1}{2}$ grs.	1-10th gr.

The water is perfectly free from nitrogenous organic

matter and is highly aërated. We have given the magnesium here as it appears in the Fresenius analysis, that is as being associated with carbonic acid, but this is not strictly correct as it is evident that a small portion of magnesium is associated with the chlorine. To make this change, however, would entirely disarrange the analysis ; and the quantity is too small to merit much consideration.

Wilhelms' Quelle is a very pure table water, strongly saline in its character, which owes its antacid properties chiefly to carbonate of calcium.

Birresborn.

This spring, which is used as a table water, is situated in the Eifel Mountains, in Rhenish Prussia. It was analysed in 1875 with great care by Fresenius, and we give his figures, calculated to grains per gallon :—

Bicarbonate of sodium	199·570
Bicarbonate of lithium	0·231
Carbonate of calcium	19·103
Carbonate of barium ... ... } Carbonate of strontium... ... }	0·010
Carbonate of magnesium	76·501
Carbonate of iron	2·458
Carbonate of manganese	0 046
Biborate of sodium, trace	
Sulphate of potassium	3·646
Sulphate of sodium	9·514
Chloride of sodium	25·033
Bromide of sodium	0·025
Iodide of sodium	0·0003
Phosphate of sodium	0·015
Nitric acid, trace	
Phosphate of aluminium, trace	
Silicic acid	1·717
Total solids	337·869
Free carbonic acid	

Skeleton Analysis of 10 *oz. fluid* (½-*pint*).

Solids.	Antacids.	Salines.	Purgatives.
21 grains.	18 grains.	1½ grains.	1 grain.

This is a table water of very marked alkaline character and slightly purgative.

Harrogate Kissingen.

Although this water is almost strong enough to be considered a medicinal water, we have inserted it here owin to two causes. It is based on the lines of a table-water, although rather concentrated (604 grains per gallon), and is also artificially aërated, to make it more palatable. We believe that this last is done at the suggestion of Prof. Attfield, who has lately examined the water. He reports as follows :—"After my experiments on the modes of keeping out the mischievous oxygen of the air, and of adding solvents of the chalybeate components of the Harrogate waters, I have no hesitation in recommending simple aëration of the waters by a due quantity of carbonic acid gas immediately they come from the spring, and, of course, immediately bottling. Aërated Harrogate waters would take immensely with the public."

This spring has been repeatedly analysed. In 1845, by West, in 1854, by Hofmann, in 1867, by Muspratt, and by Attfield in 1879. There has been very little change, as evidenced by these analyses, which were all performed by reliable men.

The total solids in the pure spring seem to have come back to the old figures of the original analyses performed in 1845, namely, about 875 grains, whilst they fluctuated to 908 and 991 in 1854 and 1867. It is interesting to remark in connection with this spring that excessive rainfalls do not, from the records, appear to

influence the composition. It would, probably, be the case in most of the similar mineral springs which, in nine cases out of ten, come from considerable depths. If a water were influenced by such rainfalls, it would give indications of surface drainage. The water is fairly chalybeate, but still this chalybeate character seems to be steadily increasing, although we have not found quite as much iron present as given in Prof. Attfield's analysis Thus the iron in 1854 was 1·34 ; in 1867, 1·79 ; and in 1879, 4·6.

It contains in the mild bottled form per gallon—

Chloride of sodium	465·63
Chloride of potassium	15·00
Chloride of magnesium	45·42
Sulphate of barium	0·35
Sulphide of sodium	trace
Carbonate of barium	1·46
Chloride of strontium	0·59
Chloride of calcium	61·18
Carbonate of calcium	6·09
Carbonate of iron	6·09
Silica	2·50
Lithium	
Ammonia	0·10
Total	604·31 grs.

Skeleton analysis of 10 *ounces fluid* ($\frac{1}{2}$ *a pint.*)

Total Solids.	Salines.	Purgatives.	Antacids.	Iron.
37$\frac{3}{4}$ grs.	29 grs.	3 grs.	1 gr.	$\frac{1}{3}$ gr.

The presence of sulphides, although very naturally to be expected, is here observed for the first time. The Harrogate Kissingen is a mild chalybeate water, possessing very little aperient properties ; in fact, only what would

be about sufficient to control the action of the iron. The Harrogate Kissingen *is perfectly pure*, gives only an alkaline reaction with phenol-phtalein after boiling some time, and even that is not permanent. It has no action upon diphenylamine or metaphenylene-diamine, proving the absence of nitrates, or nitrites. Nor does it contain any nitrogenous organic matter. It is artificially aërated by carbonic acid gas.

From the next analysis it will be seen that this spring bears a remarkable resemblance to the Bavarian Kissingen, but is a better water.

KISSINGEN (BAVARIA).

Rakoczy.

Chloride of sodium	407·543
Chloride of potassium	20·008
Chloride of magnesium	21·265
Chloride of lithium	1·401
Sulphate of magnesium	41·187
Sulphate of calcium	27·225
Carbonate of magnesium	1·192
Carbonate of iron (ferrous oxide) ...	2·210
Phosphate of calcium	·392
Silica	·903
Nitrate of sodium	·651
Bromide of sodium	·586
Carbonate of calcium	74·267
Total solids	598·83

Skeleton Analysis of 10 *oz. fluid* ($\frac{1}{2}$ *pint*).

Solids.	Salines.	Antacids.	Purgatives.	Iron.
37$\frac{1}{2}$ grs.	29 grs.	4 grs.	3$\frac{3}{4}$ grs.	·14 grs.

SAINT GALMIER.

This establishment is at Loire, in France. There are

three or four sources, but the particular one we have examined is marked Source Nouvelle (*cachet d'or*). The other waters are Source Badoit (green seal), Source André (blue seal), and Source Centrales (yellow seal). The Source Nouvelle contains—

Carbonate of magnesium and Carbonate of calcium	...	34·00
Bicarbonate of sodium...	...	18·66
Bicarbonate of potassium	...	4·23
Carbonate of strontium	...	8·49
Carbonate of iron ...	...	0·63
Carbonate of manganese, trace		
Sulphate of sodium ...	...	5·53
Sulphate of calcium ...	...	12·10
Chloride of sodium ...	...	15·12
Chloride of magnesium	...	3·10
Chloride of calcium, trace	...	
Nitric acid	...	1·83
Phosphoric acid, trace		
Lithium, trace		
Silica	...	4·20
Total solids	...	107·89

Skeleton Analysis of $\frac{1}{2}$*-pint* (10 *fluid ounces*).

Total solids.	Antacids.	Salines.	Purgatives.
$6\frac{1}{4}$	$3\frac{1}{2}$ grs.	1 gr.	$1\frac{1}{2}$ grs.

Although not a very strong water, St. Galmier is complicated in composition. It is strongly antacid in character, but chiefly owing to the magnesia and alkaline earths; it is therefore peculiar in this respect. It, however, contains a marked quantity of carbonates of the alkalies, and therefore gives a decided reaction after boiling with phenol-pthalein. It is quite pure, and contains

no nitrogenous organic matter, and is worthy of a place amongst the first-class table waters. The ingredients are very equally divided in character.

Rosbach.

The Rosbach springs are situated at Rosbach, near Homburg. Prof. Wanklyn reports that he personally inspected these springs in the autumn of 1878. He states that "the spring from which the Company draws the water is covered with a metallic hood so as to catch the natural carbonic acid, which escapes along with the water, and with which the bottles are charged." This seems to be the favourite method adopted for charging the water with the natural gas by all similar companies, but we must confess to some surprise that no better and more scientific method has been adopted. It seems to us very like the system of letting the deer escape for the pleasure of recapturing him again. According to Prof. Wanklyn, the rate of flow of this spring is 27 litres per minute, equal to 18,000,000 full bottles in the year, and its composition, according to the same authority, is—

	Grains.
Chloride of sodium	83·0
Carbonate of calcium	25·7
Carbonate of magnesium	12·6
	121·3

Skeleton Analysis of Half-a-pint (10 *oz. fluid*).

Solids.	Salines.	Antacids.	Purgatives.
7½ grs.	5 grs.	2¼ grs.	—

We have no doubt that in a general and rough sense the above represents the composition of this water, but if it did so exactly it would not be necessary for the public to

pay for such a water, as it could be so easily imitated, owing to its simplicity of composition. We have not the quantity or time for a thorough examination, having only one small bottle at our disposal, which we have devoted simply to the determination of the absence, or presence, of organic impurities. We find this water, as stated in Professor Wanklyn's report, to be fairly pure in this respect. It gives no evidence of nitrogenous organic matter. But at the same time the examination was quite sufficient to show that it is much more complicated in composition than the simple formula given above. In fact, there are certain ingredients which *must* be present in a mineral water which are not given in the above analysis.

One of the peculiarities of the Rosbach spring is the comparative absence of sulphates. In the analysis given above no sulphates are present; the bottled water contains sulphates, although in comparatively small quantities. They amounted in the sample examined to nearly two grains of sulphate of sodium per gallon. This water also contains small quantities of other salts than those mentioned.

Orezza.

This water is peculiar because it may be drank freely as a table water, yet its most marked property is its chalybeate character.

We have not analysed it, but have merely examined it as regards its freedom from organic impurities. The analysis was performed by Poggiale, and we give his figures, calculated to the imperial gallon :

Carbonate of calcium		42·14
Carbonate of magnesium		5·18
Carbonate of protoxide of iron ...		8·96
Sulphate of calcium		1·47
Chloride of potassium Chloride of sodium	} ...	0·98
Alumina		0·42
Silica		0·28
Total solids ...		59·43 grs.

Free carbonic acid 1·24 per 1,000 parts.

Skeleton Analysis of ½*-pint* (10 *ozs. fluid*).

Solids.	Salines.	Antacids.	Iron Purgatives.
3¾ grs.	3 grs.	6-100ths.	½ grain.

The Orezza spring is in Corsica, and is chiefly used in its own district for drinking purposes. It is free from organic nitrogenous matter.

Baden-Baden.

The four springs which give celebrity to Baden-Baden as a bathing establishment have lately been united into one by an extensive series of works carried on under the Grand Ducal Government. Shafts were sunk under the castle, uniting in one main shaft, the springs, Ungemach, Bruh, Höllen, and Juden spring. Some of these shafts are 400 metres long (441 yards). Prof. Bunsen has lately performed a most elaborate analysis of this water, and by operating upon immense quantities, has got out the amounts to a great nicety. Thus, to estimate the arsenic, he operated upon half a cwt. of the water. It would be presumption to pretend to refine upon such an analysis,

as it could only be performed upon the spot. We therefore give Bunsen's figures calculated to grains per gallon :

Bicarbonate of iron	·0371
Bicarbonate of magnesium ...	·2051
Bicarbonate of manganese ...	·0945
Bicarbonate of lime	11·7929
Sulphate of strontia	·3164
Sulphate of lime	14·8078
Chloride of potassium	9·3128
Chloride of sodium	141·1031
Chloride of calcium	1·4763
Chloride of lithium	3·7567
Chloride of rubidum	0·0934
Chloride of calcium	·0938
Chloride of magnesium ...	·7511
Bromide of magnesium ...	·3752
Normal calcium ortho-arseniate	·0490
Normal calcium ortho-phosphate	·0115
Silica	8·9138
Carbonic acid	1·2117
Traces of ammonia and organic matter	194·3948

Skeleton Analysis of $\frac{1}{2}$*-pint* (10 *ozs. fluid*).

al Solids.	Salines.	Antacids.	Purgatives.	Arseniate of Calcium
12 grs.	$9\frac{1}{2}$ grs.	$\frac{3}{4}$ grs.	·05 grs.	·003 grs.

Bunsen states that the combined water from this main shaft differs very little from the individual springs which he had previously analysed. In speaking of the arsenic and lithium, he says, as these two ingredients, in

particular, are of great interest in medical regard, I have taken special points to determine their amounts. The method adopted may be interesting to our readers in showing how minute composition in mineral waters is arrived at, and also as illustrating the wonderful difference a minute analysis, such as Bunsen, gives, and the merest outline, as illustrated in the analysis of the Rosbach springs.

The arsenic was precipitated from about half a cwt. of water previously concentrated, and then acidulated with muriatic acid at a temperature of from 70° to 80° (cent.) by means of sulphuretted hydrogen maintained continuously for five days. That the arsenic was not derived from the materials used in the experiment, but from the mineral water itself, was demonstrated in a counter-experiment, in which distilled water, placed in the same utensil, and subjected precisely to the same treatment, with the same chemical agents as the mineral water had been, exhibited no trace of arsenic.

Schwalheim.

Schwalheim water is not much used in this country, yet it is a very good spring of a distinctive character, namely, a water which owes its alkalinity or antacid properties entirely to the carbonate of calcium. It is also a slightly chalybeate water, and contains a small quantity of lithium. The presence of lithium was first noticed by the writer of these articles in the year 1867. The spring had previously been analysed by Liebig, but it is just possible that a change had taken place between the dates of the analyses. The writer gives his own figures. The analysis had been very carefully performed at the time, and

has since been generally adopted and used by the proprietors.

Schwalheim water contains per gallon:

Carbonate of calcium	40·400
Ferrous carbonate	1·360
Carbonate of magnesium	5·528
Chloride of potassium	3·776
Chloride of magnesium	3·992
Chloride of lithium	0·034
Chloride of sodium	97·648
Sulphate of sodium	6·056
Bromide, trace	
Silica	8·480
Carbonic acid (not determined) ...	
Total solids ...	167·274 grs.

Skeleton Analysis of $\frac{1}{2}$*-pint* (10 *ozs. fluid*).

Total Solids.	Salines.	Antacids.	Purgatives.	Iron.
10 grs.	$6\frac{1}{4}$ grs.	$2\frac{1}{4}$ grs.	$1\frac{1}{2}$ grs.	1-10th gr.

CHAPTER X.

THERAPEUTICS OF TABLE WATERS.

In studying this part of the subject it is essential to bear in mind what has already been stated with regard to the consumption of ordinary potable water in varying quantities, and at various periods of the day. All that we have there said necessarily applies to the use of such mineral waters as are recommended to be taken at table. Some of these are feebly saline, others are slightly alkaline, a third class—containing iron—are called chalybeate or tonic, while some less common constituents give a character to others. In waters intended for constant use it is obvious that the mineralisation must be moderate, and in some cases the ingredients are such that very small quantities suffice to render the water a medicinal rather than a dietetic agent. Thus table waters with a considerable quantity of salt approach in character saline waters. Those containing sodium carbonate are related to the alkaline waters, and those with small quantities of iron have a claim to be admitted into the class of chalybeates unless the proportion of metal is very small. Most of these waters contain free carbonic acid, an agreeable stomachic frequently employed in other forms, to which some of the qualities of the beverage are unquestionably due. The familiar effervescing draughts and the artificial aërated waters of

commerce have their uses. Richter has recommended artificially aërated distilled water as a menstruum, and lately it has been offered us as a beverage, as if it were a novelty.

It is an error to suppose that the value of a water is in proportion to the amount of gas it contains. A large quantity is expelled from the stomach almost as soon as swallowed, or else is liable to cause distress. Hence waters containing a moderate amount are found more digestible. When, however, a suitable water is found to contain more gas than agrees with the stomach, the dose can be allowed to stand awhile so as to let the carbonic acid escape. From 5 to 10 or 12 cubic inches per pint of water is an agreeable quantity, and within these limits the beneficial action on the stomach and bowels is most marked. It will be said that our ordinary aërated waters sometimes have a large quantity forced into them, but it should be remembered that much of this escapes the moment a bottle is opened, and many persons find it better to sip these than to drink them off. Moreover, one of their most important uses is to mix with a non-aërated fluid like milk. In the gaseous saline waters the constituents are rapidly absorbed, and the digestive energy of the carbonic acid well marked. But instead of going over the general therapeutics of table waters we will pass in review those of which we have given analyses.

Seltzer.—This claims first place as the general favourite which has longest maintained its repute. Our new analysis will correct the impression which has generally prevailed as to its ingredients, and give an idea of its action. It is both antacid and saline. The slight alkaline reaction

of the water depends on the fact that its antacid quality is, for the most part, due to alkaline earths, though, as will be seen, it does contain some sodium bicarbonate. The saline quality is largely due to the sodium chloride, which is added to the water when it is bottled. The purgatives, it will be seen, are only in minute quantity, Mr. Tichborne's careful analysis giving only one grain in the half-pint, and yet it is a common observation that the use of seltzer increases intestinal action. This confirms what we have stated as to the value of gaseous and other waters in constipation. All who require a gaseous, feebly alkaline and saline water, with a tendency to relax rather than constipate, may therefore try seltzer. Its saline constituents give it the refreshing quality which assists in allaying thirst, and the gas makes it palatable. It promotes the secretions of the skin and kidneys. It can be mixed with milk, but it is not so pleasant in this form as artificially aërated and alkaline waters. It is a pity it is not universally sold in glass instead of stone bottles.

Taunus.—Here we have a palatable calcareous table water, containing no purgatives, but as rich in salines and antacids as the seltzer. As the antacid quality is due to the carbonates of the alkaline earths, some persons may find it sit rather heavy on the stomach, and some may think it constipating. On the other hand, it might be preferred where earthy salts are supposed to be indicated.

Harzer.—This is a pure, light, antacid, saline, gaseous water, very pleasant to the taste, and grateful to the stomach. The alkaline reaction is due to sodium carbonate, and the saline quality to the same chloride. It contains even less purgatives than seltzer, so that it may be said to be non-aperient, but this minute quantity, with the other in-

gredients, suffices to render it non-constipating. It is an excellent digestive water.

Apollinaris.—This water has been so prominently brought before the public of late years that many people are under the impression that it was previously unknown. We, however, have long been acquainted with it, and some of our patients drank it regularly years before it was advertised in England. There are several springs, and we are not aware that the Company has purchased all. It will be seen that the Apollinaris water now in the market does not quite correspond with the original analyses. Prof. Tichborne finds it stronger, especially in sodium chloride, and carbonate. Of the former of these we are informed that a certain quantity is added. It would be interesting to learn whether any of the latter is also artificial, as otherwise the spring would appear to be increasing in strength, for we can scarcely suppose that so ordinary a salt would have been erroneously computed.

It may surprise some to hear that Apollinaris is closely related to seltzer, and yet a comparison of the analyses will show that this is the case. The two contain nearly the same quantity of solid ingredients, and they are distributed in a similar manner. Still there are some differences. Thus Apollinaris contains in half-a-pint more antacids and less salines than seltzer, and it has half as much again purgatives. It is, therefore, quite as digestive, rather more antacid, and more likely to increase the action of the bowels. It has a good supply of gas, and is tolerably palatable. Personally we should prefer it without the added salt. The Company boast so much of the "Chemistry of Nature" that they might perhaps make the effort to abide by her works without the additions of art.

Adelheidsquelle.—This is a much stronger water, containing nearly 29 grains of solids, as against 17¼ in seltzer. The strength is due almost entirely to the salines, which amount to nearly 24 grains. The antacids are rather less than seltzer, but the alkaline reaction is well-marked, being due chiefly to sodium carbonate. The purgatives are so slight that they may be practically disregarded. The presence of iodides and bromides make this a useful table water where those salts are indicated in combination with salines, or may lead to the selection of this where a saline water is wanted for a patient taking pharmaceutical preparations of iodine and bromine. It has some claim to be considered a medicinal as well as a dietetic water, and has considerable repute in glandular and cutaneous affections.

Gerolstein is a light, antacid, well aërated water, grateful to both palate and stomach. The mineralisation is slight, and composed chiefly of antacids, these being nearly equally alkaline bicarbonates, and carbonates of the alkaline earths. Compared with seltzer it contains less total solids, but much more antacids, one-half the quantity of purgatives, and scarcely any salines. It is then as a pure, digestive, mildly antacid, table water that Gerolstein must be employed. It mixes well with milk and may be taken freely as a beverage.

Bellthal.—Antacid, contains only eleven grains of solids in a pint, but the presence of nitric acid, ammonia and phosphates is objectionable.

Wilhelms' Quelle.—A light, saline, highly aërated, feebly antacid water, the last property being chiefly due to calcium carbonate. There is also a small quantity of iron and traces of bromides, and iodides. This water has

obtained a high reputation, and, as it is pleasant and perfectly free from organic matter, deserves a trial.

Birresborn—This is a more decidedly alkaline water, out of the twenty-one grains of salts in the half-pint no less than eighteen being antacid. With a grain of purgatives it may sometimes seem aperient, and in no case would constipate. It should suit well when seltzer is not sufficiently antacid.

Harrogate Kissingen may be used as a table water when chalybeates are indicated as well as a saline beverage. It may, however, be fairly classed as a medicinal water. It contains thirty-eight grains of solid matter in the half-pint, of which thirty-four are the salines, distributed after the manner of table waters. The same quantity also contains 1-3rd grain of iron, giving it a ferruginous character, and three grains of salts, which may be sufficiently aperient to counteract the tendency of the iron to produce constipation. The water is artificially aërated and will therefore keep in bottle. This water is closely related to that of one or two springs at Kissingen in Bavaria.

Saint Galmier.—This has long been a favourite table water in France, and most people who have travelled in that country are acquainted with it; it has been called the French Seltzer water. It is a light, digestive beverage, containing quite a number of ingredients, distributed in excellent proportions. Thus it furnishes a light, antacid drink, uncomplicated with much saline matter, only 1 gr. in the half pint, and with just enough aperients to prevent it from constipating. It may be mixed with other drinks without spoiling them, is somewhat aërated, and is perfectly pure. It is quite a typical table water.

Rosbach is aërated at the springs by the natural gas which escapes. It seems to be a saline water, feebly antacid, and without a trace of aperients.

Contrexéville is a light water, with 1¼ gr. in the half pint of antacids, and the same amount of salines, but these springs yield traces of arsenic and of iron. For a century and a quarter the value of the water has been asserted by medical authorities, and it is nearly as long since English invalids began to visit the village. The waters are in most repute for gout, and diseases of the bladder, and prostate. In most disorders of the urinary organs, a systematic course has been recommended. Civiale expressed a strong opinion as to their great utility, and there seems no question that they do determine to the urinary system. Durand-Fardell (*a*) recommends Contrexéville in renal colic and in catarrh or inflammation of the kidneys when Vichy or other alkaline waters are contra-indicated. An attempt has been made to treat diabetes by this water, to which may be added, that it would be found a suitable water when arsenic is being taken, as it contains a trace of that element.

Orezza is a valuable, highly sparkling, chalybeate water containing sufficient iron to give it a claim to a position as a medicinal article, though it may also be used as a beverage by patients who would be benefited by steel. In anæmic cases it may, therefore, be used as a tonic table water.

Schwalheim is a sparkling, very slightly chalybeate water, with some antacid properties and no tendency to constipate. It contains also some salines and is agreeable to take. The iron is in less quantity than in Orezza—as one-tenth to one-half.

(*a*) Traité Pratique des Maladi Chroniques. 1868

Baden-Baden has lately made great efforts to increase the attractions of its springs, and Prof. Bunsen finds the waters contain arsenic. His elaborate investigation shows that the water is constant in its composition and the supply is unlimited. It contains 12 grs. of solids in the half pint, the salines being $9\frac{1}{2}$, the antacids $\frac{3}{4}$, with a trace of purgatives and arsenic. This water sits well on the stomach and may be found an agreeable beverage when arsenical preparations are being taken or may be utilised as a menstruum for them.

Besides the foregoing, there are springs at Buxton, Bath, Malvern, and other English resorts from which waters are furnished, which may be taken at table, as indeed may the waters of many "Holy Wells" scattered over the country, and in more or less local repute. To this class may also be added the weaker saline waters in so much esteem on the Continent. The water of Purton Spa has been usually classed with purgatives, but the aperient property of some of its ingredients is almost entirely neutralised by others, and claims are made for it on account of its bromides and iodides. We have, however, employed this, and some others, as a table water, after the manner spoken of in reference to those containing arsenic or iodides.

CHAPTER XI.

CHEMISTRY OF CHALYBEATE WATERS.

In considering the table waters, we have given the analyses of many which possess unmistakeably a ferruginous character; also many such will be found amongst the purgative waters. But to illustrate the confusion that exists in the classification of mineral waters let us look for an instance at the published analysis of a Rhenish spring, called Roisdorf. It is called a *table* water, but if we critically examine the analysis put forward by Bischof, we find that it is a strongly marked chalybeate water, or rather we should say that its chalybeate character is more strongly marked than its saline, or carbonated characters.

For instance, it only contains $5\frac{3}{4}$ grains of total solids per half pint, and 1-8th grain of this is iron. In fact, 1-46th of the entire solids is carbonate of iron—unaccompanied by any amount of purgatives, and only a trace of carbonate of sodium. We are only theorising upon the published analysis, as we have had no opportunity of examining the character of the water. We give the published analysis by Bischof, calculated to grains per gallon:

Roisdorf Stahlquelle.

Carbonate of soda	13·8
Chloride of sodium	38·6
Carbonate of lime	21·8
Carbonate of magnesia	10·3
Carbonate of protoxide of iron ...	2·0
Silica	7·0
	93·5

Skeleton Analysis of ½-pint.

Total solids.	Salines.	Antacids.	Iron.
$5\frac{3}{4}$ grains.	$2\frac{1}{2}$ grains.	$2\frac{3}{4}$ grains.	$0\frac{1}{8}$ grain.

Such a water in fact is a mild, but well-marked chalybeate. It contains in proportion to the solids therein more iron than Homburgh, or similar waters. It is only the small amount of solids present which enables it to be taken with impunity.

Homburgh.

The Homburgh springs are very justly celebrated. The salubrity of the district and fine bracing mountain air make the locality one of great resort. It is besides very accessible, being about three-quarters-of-an-hour from Frankfort. There are many springs, but the chief one imported is the Elisabethbrunnen. The Elisabeth spring is rather laxative, owing to the considerable amount of chloride of magnesium present. It has been previously examined by Liebig, but as the analysis is somewhat old, we subjoin our own. Lithium is now noted for the first time, and occurs in very marked quantity in the water as imported :

Elisabethbrunnen.

Chloride of sodium ...	... 555·0
Chloride of magnesium ...	... 70·0
Chloride of lithium ...	... 0·8
Carbonate of iron (ferrous)	... 4·1
Carbonate of calcium ...	... 160·9
Carbonate of magnesium ...	... 18·0
Sulphate of sodium ...	... 5·4
Sulphate of aluminium ...	... 0·8
Silica	... 3·0
Organic matter, trace	
	818·0 grains

Skeleton Analysis of 10 *ounces fluid, or* ½ *a pint.*

Total solids.	Salines.	Antacids.	Purgatives.	Iron.
51·1 grs.	34·5 grs.	11·4 grs.	4·7 grs.	·25 gr.

The Homburgh water is imported in stone jars, and gives a slight deposit on standing.

Liebig's analysis when calculated to grains per gallon gives—

Chloride of sodium ...	... 791·5
Chloride of magnesium ...	... 77·9
Carbonate of protoxide of iron	... 4·6
Carbonate of calcium ...	... 109·9
Carbonate of magnesium ...	... 20·10
Sulphate of sodium ...	... 3·8
Silica	... 3·2
	1011·0

which would give a skeleton analysis as follows—

Total solids.	Salines.	Antacids.	Purgatives.	Iron.
63·2 grs.	49·4 grs.	8.1 grs.	4·8 grs.	·28 gr.

Spa.

The important and valuable mineral water imported from Spa is stated to be the "Pouhon Prince de Condé" spring, as the original Pouhon spring is all consumed at the Spa grounds, or is used in the baths. It seems to differ a little from the published analysis, owing probably to the above facts; no doubt the one published was performed with the water from the Pouhon spring. It contains in the imperial gallon—

Carbonate of iron (ferrous condition)	1·4
Carbonate of manganese	0·2
Bicarbonate of sodium	4·7
Carbonate of calcium	4·6
Carbonate of magnesium	4·3
Sulphate of potassium	0·3
Sulphate of sodium	0·14
Chloride of sodium	1·7
Phosphate of calcium	19·0
Phosphate of aluminium	0·7
Silica	2·0
Lithia, trace	
Ammonia, trace	
Organic matter, trace	
Albuminoid ammonia	·002
Total solids ...	39·042

Carbonic acid not determined.

The above is almost identical in character with the published analysis, but much weaker. The sample examined contained a trace of sulphuretted hydrogen, but as this substance has never been noticed as being present in the Spa we can only draw the inference that it was produced by reducing action of the organic matter upon the sulphates.

Total solids.	Antacids.	Purgatives.	Salines.	Iron.
2·39 grs.	0·8 grs.	·008 grs.	·106	·087

It gave with phenol-phtalein a well-marked re-action, and is thus decided alkaline; this reaction being permanent after boiling.

Wiesbaden.

The Wiesbaden waters of Nassau are extensively used in gout and gouty diseases generally. Therefore we give one here. There are twenty-three springs, the most important of which is the Kockbrunner. This spring has been elaborately analysed by Fresenius, and we give his analysis converted to our usual standard, viz., grains per gallon. It is a slightly *chalybeate* saline, containing lithia and arsenic in the form of arsenic acid. But its most striking peculiarity is the presence of chloride of ammonium in very large quantity. The waters of Wiesbaden are said to have a taste like chicken broth, and perhaps it is due to the presence of this salt, or other nitrogenous product, which gives it the meaty flavour.

It contains per gallon—

Chloride of sodium	524·97
Chloride of potassium	11·97
Chloride of lithium	0·01
Chloride of ammonium	91·28
Chloride of calcium	36·17
Chloride of magnesium	15·66
Bromide of magnesium	0·27
Iodide of magnesium (trace)	
Sulphate of calcium	6·92
Phosphate of calcium	0·03
Arseniate of calcium	0·01
Carbonate of barium (trace)	
Carbonate of strontium (trace)	
Carbonate of calcium	32·10
Carbonate of magnesium ...	0·79
Carbonate of protoxide of iron ...	0·43
Carbonate of manganese... ...	0·04
Silica...	4·60
Silicate of alumina	0·03
Organic matters (trace)	
Total solids	725·28

Carbonic acid, 64·1 cube inch.
Nitrogen, 1·03 cube inch.

Skeleton Analysis of 10 *ounces fluid, or* ½ *a pint*

Total solids.	Salines.	Purgatives.	Antacids.	Chloride of Ammonia.
45·4	33·6	·98	·27	5·7

Iron.
0·3

HARROGATE.

Chloride of Iron Spring.

According to the excellent treatise upon the Harrogate Waters by Dr. G. Oliver, the chloride of iron water of Harrogate may be considered as unique, and one of the most important chalybeate springs known, the chief points being the occurrence of protochloride of iron. This salt is stated to have only been found in two other springs, viz., at Alexisbad and the Selkebrunnen springs. Besides occurring in much smaller quantities than in the Harrogate waters it is associated with other iron salts, such as the sulphate. The writer of the present work is quite prepared to endorse the remarks as regards this water being unique. In most of the waters examined the iron exists as ferrous carbonate, or is the direct result of the oxidation of pyrites. In such a case it is found chiefly associated with sulphuric acid. Dr. Oliver says, "it is the only ferruginous water known in which iron is linked purely with chlorides." The very large proportion of barium present may in a great meaure give a clue to the absence of the sulphates, and the occurrence of nearly 5 grains of chloride of barium per gallon is, in itself, enough to render this spring unique. We also find considerable quantities (according to the late analysis of Professor Thorpe) of manganese and bromine.

We give Thorpe's analysis, as being the latest, and pre-

mising that very little change has been shown of late years. We cannot agree with the statements, however, which make out this Harrogate water as unchangeable; either the analyses which have been quoted from time to time are wrong, or the water is subject to some fluctuations.

The greatest fluctuations seemed to have occurred in 1872, when the chloride of iron fluctuated from 34½ grains per gallon to 26½ grains. It is now 13¼ grains per gallon.

The following is Prof. Thorpe's analysis :—

Chloride of Iron Spring.

Chloride of ammonium	·41
Chloride of iron	13·22
Chloride of barium	5·21
Sulphate of barium	·20
Chloride of strontium	·63
Chloride of manganese	·97
Bromide of magnesium	·34
Chloride of sodium	277·56
Chloride of potassium	2·96
Chloride of magnesium	57·32
Chloride of calcium	94·02
Carbonate of iron	11·05
Silica	1·42
Traces of iodine, lithium, and copper	
	465·31

Miller gives the gases as being

Carbonic acid gas	3·28	cubic inches
Nitrogen	1·07	per pint.

The skeleton analysis of half a pint (10 fluid ounces) gives—

Total salts.	Salines.	Antacids.	Purgatives.	Iron.
29·0 grs.	23·0 grs.	·0	3·5 grs.	1·5 grs.

Although the carbonic acid present is sufficient to render this water a good keeping water, it is not aërated like any of the Continental waters.

The Kissingen Harrogate spring already described in this work is called in Dr. Oliver's work, the aperient chalybeate, but in the bottled specimens examined it did not appear to be nearly as strong as the analysis shown in Dr. Oliver's work. (*See* Kissingen Harrogate.)

Royat.

There are four springs at this place, which is a short distance from Clermont. Dr. Candellé, in his "Manuel de Médecine Thermale," says that this is the Ems of France. He gives a very elaborate analysis of one of them, which, he says, is the most important, "Eugenie." We have not been able to get this water, and have, therefore, analysed St. Mark.

As, however, Eugenie water is said to be the most important, we give it as it appears in Dr. Candellé's book, converting the grams per litre into grains per gallon.

Eugenie.

From Candellé's work.

Bicarbonate of soda...	94·43
„ potash	30·45
„ lime	70·00
„ magnesia	47·00
„ iron...	2·80
„ manganese (trace)	
Sulphate of soda	12·95
Phosphate of soda	1·26
Arseniate, iodide, and bromide of sodium (traces)	
Sodium and alumina (traces)	
Chloride of sodium	120·96
Chloride of lithium	2·45
Silica	10·92
Organic matter (trace)	
Total	393·22 grains.

Skeleton Analysis of ½ a pint (10 ounces fluid).

Total solids.	Antacids.	Salines.	Purgatives.	Iron.
24·6 grs.	15·3 grs.	7·7 grs.	·8 gr.	·17 gr.

The four Royat Springs are Eugenie, Cæsar, St. Mark, and St. Victor. According to the published analyses, there is not much difference. They all appear to contain iron in considerable quantities, but St. Victor seems to be doubly as strong when viewed as a chalybeate. Lithium is also present in St. Mark and St. Victor waters, and occurs in rather considerable quantities ; but it is not mentioned in analyses of Lefort, performed in the year 1857, of the Eugenie and Cæsar waters. The St. Mark's and St. Victor analyses are by Truchot, and performed at a

much later period (1875); this fact may account for the difference. We have only been able to examine "St. Mark," but do not consider it necessary to give Truchot's analyses.

St. Mark.

Bicarbonate of soda	51·2
Bicarbonate of potassium	10·9
Carbonate of calcium	37·1
Carbonate of magnesium	23·7
Carbonate of iron (ferrous salts) ...	1·4
Sulphate of sodium	10·5
Phosphate of sodium (trace)	
Arsenic (trace)	
Chloride of sodium	99·8
Chloride of lithium	2·2
Silica, &c.	4·8
Ammonium	1·002
Albuminoid ammonia (trace)	
Total solids	242·602

Skeleton Analysis of ½ a pint (10 ounces fluid).

Total solids.	Antacids.	Salines.	Purgatives.	Iron.
15·1 grs.	7·6 grs.	7 grs.	·4 gr.	·08 gr.

This water gives a very marked alkaline reaction with phenolphtalein, which is not only permanent, but is greatly intensified by heat; the alkalinity being due to the large proportion of sodium and potassium carbonates.

Pyrmont.

Once the most celebrated spas in Europe, and certainly one of the oldest watering-places; it was frequented by Charlemagne. The mineral waters were so celebrated in the year 1556 that a camp had to be erected outside the

town. The concourse of visitors have, however, very much fallen off. Pyrmont contains about twelve or fourteen springs, and many of them are specimens of highly-charged waters. It is stated that when several glasses of Trinkquelle water are taken in quick succession a feeling of intoxication is produced for a short duration. This spring is said to contain the largest quantity of carbonic acid gas of any known German spring. There is a gas douche, which is said to be very powerful; but at the same time there is one of the springs which is totally without gas. Near here is the Dünsthohle, or Gas Grotto. This is a cavity from which rises a stream of carbonic acid gas, which, if breathed, is fatal to life. Rabbits and dogs, when thrown in, are killed in the same manner as the celebrated Grotto del Cane in Naples.

Trinkbrunnen.

Carbonate of calcium	104 80
Sulphate of calcium	90·04
Carbonate of magnesium	1·13
Sulphate of potassium	3·34
Sulphate of sodium	15·12
Ferrous carbonate	3·78
Manganeous carbonate	0·23
Chloride of sodium	6·15
Chloride of lithium	0·26
Nitric acid (trace)	
Ammonia (trace)	
Albuminoid ammonia (minute trace)	
Alumina	0·10
Silica	0·27
Total solids per gallon ...	225·22 grains.

Skeleton Analysis of ½ a pint (10 ounces fluid).

Total solids.	Antacids.	Purgatives.	Salines.	Iron.
14·	6½	1·	½	·2

This water gives very little action with phenolphtalein.

Shelfanger.

Another mineral spring, found near Diss, in Norfolk, has lately come into prominence. According to the statement of the proprietors, it flows from a fossiliferous district of old formation. As it is a mild chalybeate water (three grains per gallon), it is recommended as a table water. Being accompanied by magnesium carbonate and chloride, it is also mildly aperient. An analysis of this water by Dr. Attfield was made before it was aërated and bottled for public use, and as the proprietors omitted to have it completed we are compelled to give an analysis of our own. The result after examining the bottled waters is not quite identical either with some of the figures given in the above-named report.

The Shelfanger water is a chalybeate of some considerable interest, and peculiar in its composition. It possesses considerable antacid properties, but the said antacid properties may be said to be almost entirely due to carbonate of magnesium, and, although the amount of strong purgatives (Glauber's and Epsom salts) are next to nothing, yet this water will have a slight laxative character, owing to its magnesian salts being in preponderance. The astringent character, therefore, of the iron seems to be fairly balanced. One of the most striking points about this water is its nice flavour, and absence of disagreeable styptic taste, so frequently found in water where iron is present.

The Shelfanger spring gives, on analysis, grains per gallon—

Carbonate of magnesium ...	23·58
Carbonate of calcium	2·45
Carbonate of iron (ferrous salt) ...	2·90
Chloride of magnesium	4·81
Sulphate of magnesium	0·49
Sulphate of calcium	1·20
Sulphate of sodium	3·00
Ammonia chloride	1·70
Albuminoid ammonia (trace 0·016)	
Nitrates and nitrites (equal to $N_2 O_5$)	0·079
Silica	0·21
Total solids	40·419

Skeleton Analysis of ½ a pint (10 *ounces fluid*).

Total Solids.	Antacids.	Purgatives.	Salines.	Iron.
2½ grs.	1¾ gr.	½ gr.	1-10th.	2-10th

The Shelfanger water was examined in bottle in its unaërated state and its aërated condition. In both conditions it was almost identical in strength ; therefore, this water is not aërated by mixing with aërated water, but is charged directly with the carbonic acid gas. It gave no action with phenol-phtalein in the cold, but on heating became slightly coloured, this colour disappearing again on cooling. We therefore see that the antacid properties are due entirely to alkaline earths, and not to alkalies. The condition of the nitrogen acidulous radicals was about equally divided between nitric and nitrous acid in the samples examined. This is probably owing to the reducing action of the iron, because the small amount of albuminoid ammonia proves this water to be comparatively free from organic impurities. We should think Shelfanger would prove a most valuable table water where a mild tonic is indicated.

CHAPTER XII.

THERAPEUTICS OF CHALYBEATE WATERS.

A MORE moderate estimate is now entertained than that which formerly prevailed concerning the value of chalybeate waters. This change of opinion may be partly due to the reaction which naturally follows exaggerated views, but is probably still more to be attributed to the progress of chemistry having placed at our disposal so many ferruginous preparations. Moreover, careful study of the therapeutics of iron has led to greater discrimination in its use. The best effects of the metal can usually be obtained from appropriate pharmaceutical preparations, but we need not, therefore, overlook the benefits which so often accrue from the complete change involved in a visit to one of the many agreeable spas. Many cases of poverty of blood are easily cured by diet, fresh air, exercise, and other influences which promote nutrition. The healthy system can extract sufficient iron from a suitable diet. On the other hand, there are many cases in which the deficiency of this constituent of the body is best directly supplied by the presentation of the metal to the stomach in a suitable form.

Generally speaking, the more acute and direct the anæmia, the more rapidly will the iron be assimilated. As a

necessary constituent of the body, the metal may be regarded as a food. Its deficiency is at once shown in a change in the blood, the corpuscles of which are rapidly replaced under its influence. Its hæmatinic effect can therefore be determined in any given cases by counting the corpuscles. But for this purpose only small doses are required, and should be given in the most easily assimilable form. It has been estimated that in health a grain per day is usually taken up and removed, but in some chlorotics that four or five times as much has been for a short time assimilated. Further estimates have been formed of the total deficiency of iron that may take place in disease and be restored by treatment. According to these calculations, the deficiency never exceeds 15 or 20 grains ; from 37 to 47 grains are present in the blood of a healthy adult. The blood will not take up more iron nor form more hæmatin than the normal amount, so that we cannot increase the richness of the blood beyond the standard of health. But it does not follow that unlimited quantities may be given. On the contrary, large doses are likely to derange the digestive organs, and thus defeat the object with which they are given. They impede the secretions, and thereby hinder absorption and constipate the bowels. Something, of course, depends on the form in which the iron is presented, the preparation, and the degree of dilution ; something, too, on the state of the stomach. The presence of carbonic acid is also a point not to be overlooked, and we have already discussed the effects of this gas. The unabsorbed portion of the dose passes away in the fæces, chiefly as a sulphide, and is the cause of the blackening of the evacuations. Small quantities of sulphide constipate by checking the secretion of the intestinal mucous membrane, but larger quantities may act an an irritant, and so produce diarrhœa.

After absorption iron is eliminated by the kidneys, skin, and liver. It chiefly passes into the urine, and the rate at which this occurs seems to accord with the rate of absorption, the amount excreted increasing with the smallness of the dose taken.

Somewhat contradictory results have been reported as to the effect iron has on the pulse. It is reported generally to give tone to the circulation and to make the pulse slower. Others, however, state that it increases the frequency of the pulse, and it is a common observation that it appears to increase congestions. The effects of iron waters, which contain carbonic acid, ought not to be brought forward to elucidate this question, as the gas itself would manifestly affect the result. As the iron favours oxidation, it may be assumed that this tends to increase the production of heat and to quicken the pulse, but this last symptom may be more than neutralised at a later stage by the increased strength which follows improved sanguification. Iron would seem to give tone to the capillaries and even to stimulate their contraction, to which effect may be partly ascribed its power over hæmorrhages and discharges.

If the final use of iron in the system cannot be completely traced, we may certainly conclude that it is necessary to the formation of the blood globules, and when deficient should be supplied in the lightest form. The small quantity present in chalybeate waters is sufficient to produce the therapeutical effects just as in the cases of other preparations. Small doses, as already stated, are most efficient. In the mineral waters carbonic acid is a frequent constituent, and this will often stimulate the stomach and prove an excellent digestive. When too abundant a portion may be allowed to escape, and,

indeed, when the bottled waters are used they may often be safely warmed, and will then be more grateful to delicate stomachs, for, as previously shown, large quantities of gas are often injurious. In most of these waters the iron exists as a carbonate of the protoxide. Those which contain the sulphate are much heavier, and disagreeable to the palate. They are, however, occasionally useful.

Some of the weakest chalybeate waters have been spoken of in our account of table waters. We have now to enumerate those of which an analysis has been given in the last chapter.

Roisdorf contains only a small amount of solid ingredients. The proportion of iron gives it a distinct value as a mild, uncomplicated, chalybeate water.

Homburgh is more frequented for its salt springs, while its position makes it a favourite resort. Nevertheless, it boasts its iron spring, with which the other treatment may be combined or supplemented. We do not frequently employ the bottled waters.

Spa, the name of which has become generic, is an agreeable and easily accessible resort, where the chalybeate waters can be supplemented by luxurious bathing, horse exercise, and other agreeable circumstances. The town is situated 1,000 feet above the sea level, in one of the valleys of the Ardennes, and is a pleasant, bracing, but mild resort. The bottled waters seem to be rather weaker than those of the principal spring—the *Pouhon*, but they are of the same character.

Wiesbaden, so famous for gout, is generally classed with salt waters, the proportion of chloride of sodium being large. It also contains chloride of ammonium—as much as 5·7 grs. per half-pint. The saline ingredients are 33·6 grs. out of a total of 45·4, and the iron is only 0·3. It also

contains arsenic. Only one of the seventeen wells is used for drinking, the fame of Wiesbaden depending on its thermal baths.

Harrogate, so renowned for its sulphur waters, has also a remarkable iron spring, in which the metal is found as a chloride. This well is a most valuable addition to the other springs of this celebrated English resort, the bracing climate of which is more tonic than that of many Continental spas. There are other constituents of this water which add to its value, and give it a position quite unique.

Royat is often classed with Ems, for which it is a very good substitute, while its climate is better, for being 1,380 feet above the sea (Ems is only 291), the heat in July and August is not so great nor so oppressive as at Ems. It is a mild alkaline chalybeate water, and is recommended in mucous catarrhs, and dyspepsia attended with anæmia.

Pyrmont, once the leading chalybeate spa, still offers sufficient attractions to make a sojourn pleasant, while its waters have for centuries held a high place among chalybeates. They are highly charged with carbonic acid, and the stimulating effect of this is compared by some enthusiasts to that of champagne. The water is agreeable to the taste. The iron is here associated with calcareous salts.

Shelfanger, a mild alkaline chalybeate, in which the ron is associated with magnesia, does not seem to constipate, and is of agreeable flavour.

CHAPTER XIII.

CHEMISTRY OF SULPHUR WATERS.

THE remarks that have generally headed the different sections of these articles apply also to sulphur waters (or, as we would prefer to call them, sulphurated waters), but perhaps in a less degree. The disagreeable smell, in the first place, militates against their use as table waters, however mild they might be in their action. The same objection partially applies to their use as aperient waters. They are, however, most valuable from a medicinal point of view. Most of the better sulphur waters owe their activity to the presence, as we have already indicated, of alkaline sulphides, the presence of small quantities of free sulphuretted hydrogen being due to decomposing or dissociating action of the carbonic acid gas. Any waters which owe their properties alone to the presence of sulphuretted hydrogen gas are of very little use medicinally, and are certainly not suited for exportation, because the modicum of gas is very soon converted into

other products. We doubt very much if such waters can act practically as carriers of sulphur into the blood when drank. We find, according to Dr. Oliver's work on the Harrogate waters, that the amount of alkaline sulphide in most of the well-known sulphur springs differs very considerably, and that, with one exception, the richest waters in this respect are to be found in England. The importance of this question in connection with this section of our work must be our excuse for quoting from his book.

	Parts of Alkaline Sulphide in 10,000 parts of water.
Challen (Willin)	3·59
Harrogate Montpellier	2·07
Harrogate Old Sulphur Well ...	1·18
Mehadia Schneider and Kottsdorfer	1·07
Harrogate Mild Sulphur ...	0·98
Luchon	0·77
Marlioz	0·67
Strathpeffer	0·26
Barèges	0·22
Eaux Bonnes	0·21
Amélie	0·12

There are other analyses given, but we have taken those which are most celebrated as sulphur springs, or have been lately analysed.

Harrogate Old Sulphur Well.

We see that, with one exception, we possess in Harrogate the two most powerful sulphur springs in the world. The most celebrated at Harrogate—although not the highest in strength—is the Old Sulphur Well. We give the

figures of Dr. Hofmann's analysis, although now performed some years ago, and also the more recent ones of Prof. Thorpe—

	Hofmann.	Thorpe, 1875.
Sulphide of sodium ...	15·48	5·22
Sulphate of calcium ...	0·13	
Carbonate of calcium ...	12·37	29·77
Carbonate of magnesium		5·98
Fluorine	trace	
Chloride of calcium ...	81·74	43·61
Chloride of magnesium ...	55·69	48·28
Chloride of potassium ...	64·70	9·59
Chloride of sodium ...	860·18	893·66
Barium chloride ...		6·56
Lithium chloride ...		·75
Ammonium chloride ...		2·28
Magnesium bromide ...	trace	0·11
Magnesium iodide ...	trace	trace
Carbonate of iron (trace)	trace	
Silica	0·25	
Manganese ...	trace	
	1090·54	1045·81

Gases—Thorpe.

Carbonic acid	40·10 cubic inches.
Sulphuretted hydrogen ...	10·16 ,,

Thorpe combines half his sulphur with hydrogen; Hofmann all with the sodium.

Skeleton Analysis of ½ a pint (10 *fluid ounces*).

	Total solids.	Salines.	Purgatives.	Antacids.	Sulphides.
Hofmann	68	57¾	3½	¾	·9
Thorpe, 1875	65½	56½	3	2	·3

The strongest sulphur well at Harrogate is the following—

Montpellier.

	Grs. per gallon.
Chloride of sodium ...	... 827·37
Chloride of potassium ...	... 4·82
Chloride of magnesium ...	... 57·99
Chloride of calcium ...	... 79·57
Carbonate of calcium ...	... 8·75
Sulphate of sodium ...	... 14·50
Silica	... 3·57
Sulphate of barium ...	... 0·42
Chloride of strontium ...	... 2·82
Sulphate of strontium ...	... 0·53
Nitrate of sodium ...	... 0·89
Chloride of ammonium ...	... 0·99
Carbonate of iron ...	... 0·41
Total solids	... 1002·63

Skeleton Analysis of half a pint (10 *fluid ounces*).

Total solids.	Salines.	Purgatives.	Antacids.	Sulphide of sodium.
63 grs.	52½	4½	½ gr.	9-10ths.

Besides the sulphur and chalybeate waters, Harrogate possesses a spring called the Alum well, containing over 88 grains of aluminium to the gallon—also a very large proportion of iron, as *ferric sulphate* and ferrous carbonate. This curious styptic spring has been carefully analysed by Mr. Davis. His paper on the subject will be found in the *Journal* of the Chemical Society. The alum well is situated in the middle of sulphur wells, and is perhaps more a chemical or geological curiosity than a useful mineral spring. It is generally supposed

to have a mere superficial origin, and probably is therefore impregnated with products from recent geological formations.

Aix-la-Chapelle.

Almost intermediate between Holland, Belgium, and Prussia stands Aix-la-Chapelle, another of the well-known old watering places which date back to the Roman period, at which time it was known as *Aquis Granum;* it is on German ground. The warm springs induced the bath-loving Romans to settle here, and the great Charlemagne was born here. He raised the town to the rank of the second city in the Empire, and the remains of ancient baths are still being constantly uncovered in excavating. The mineral springs rise in the centre of the town, and remain unto the present day the most important in Germany. The waters are divided into the upper, which are the hottest; the lower are comparatively cool. The chief spring is the Source de l'Empereur. This spring contains a large quantity of sulphur, but not, as stated, a larger quantity of sulphur than any other known in Europe. Where the vapour arising from it, is confined and not allowed to escape, it deposits crystals of sulphur. The Emperor's spring supplies two or three baths. Besides the sulphur water there are chalybeate springs at Aix, but they are not of much importance. The town has greatly regained its prosperous condition, and although manufactures help that prosperity, the mineral springs are a fruitful source of wealth.

Aix-la-Chapelle Source de l'Empereur.

The analysis of Baron Liebig very nearly agrees with our own determination, although that analysis was performed many years ago. The water is relatively

unchanged as regards its ingredients, but it seems to have lost strength a little. Thus, Liebig found in the Kaiserquelle Spring 315 grains of total ingredients, whilst we have found the bottled water only to contain 283 grains per gallon. Our analysis gives (grs. per gall.)—

Chloride of sodium	185·75
Bromide of sodium	0·25
Iodide of sodium	0·04
Sulphuret of sodium	0·62
Bicarbonate of sodium	48·15
Sulphate of sodium	19·70
Sulphate of potassium	11·43
Carbonate of calcium	10·80
Carbonate of magnesium ...	3·51
Carbonate of strontium	0·01
Carbonate of lithium	0·06
Carbonate of iron (ferrous salt) ...	0·55
Silica	3·20
Organic matter (trace)	
Total solids	284·07

Skeleton Analysis of 10 *ounces* ($\frac{1}{2}$ *pint fluid*).

Total Solids.	Salines.	Antacids.	Purgatives.	Sulphides.
$17\frac{3}{4}$	$11\frac{1}{2}$	4	$\frac{3}{4}$	0·04

The gases given off by the Aix-la-Chapelle waters seem peculiar. According to the analysis of Liebig of the Emperor's Spring, 100 volumes consist of—

Nitrogen	66·98
Carbonic acid gas	30·89
Carburetted hydrogen	1·82
Sulphuretted hydrogen	0·31
Oxygen (none	
	100

It is not stated in what proportion these mixed gases are found in the water. Dr. Madden ("The Spas and their Uses," 3rd edition, p. ili.) says that the gas in this water contains a larger amount of nitrogen than any other European snlphurous spa.

The Borcette district, a short distance from Aix, is teaming with sulphurous springs, not differing much in character from those found at the parent town.

Barèges.

The curious and interesting series of waters of the Pyrenees may be said to culminate in the springs of Barèges, which possess a composition of a well-marked and distinct character. They are all sulphur waters. The long street which constitutes the town of Barèges and its surroundings are dismal in the extreme. It is the most elevated watering-place in Europe, which makes the climate cold and variable. Dr. Madden says: "None but those who absolutely require the waters are to be met with in Barèges, for nothing else could, I think, induce any one to pass a single week in the village." Dr. Candellé says: "*Ce village composé d'une longue rue d'aspect assez triste.*" Again, "*La sulfuration est d'une grande stabilité, aussi ces eaux sont-elles reconnues comme le plus energiquement excitantes de toute la chaine,*" &c. It seems that from this last reason thousands of visitors congregate here during the season. There must be something peculiar about a water which can attract under such dismal surroundings. Every visitor is a true invalid. The importation of the Barèges water bottled should be enhanced by these facts where such a water is required. The bottled condition is almost its proper application. We should have liked to have had facility for examining this water

in quantity, as the existing analysis is not, in our opinion, reliable, or at least, it does not bear any resemblance to the water which has come into our hands, and which is labelled *Eaux Sulfureuses Naturelles de Barèges, source du Tambour—Sulfureuse, Chlorurée, Silicatée.*

We find that Barèges contains—

	Grs. per gallon.
Sulphate of calcium	1·70
Sulphide of sodium	3·15
Sulphate of sodium	5·75
Chloride of magnesium	1·21
Chloride of sodium	3·00
Free alkali determined as hydrate of sodium	1·90
Silica	8·66
Iron	0·40
Ammonia, albuminoid, trace (0·018)	
Organic matter, crenic acid, &c. (called Barègine, locally) ...	1·20
Strontia, trace	
Total solids	26·97

The alkali which reacts upon the phenol-phtalein is probably combined with silica.

Skeleton Analysis of ½ a pint (10 ounces fluid).

Total Solids.	Purgatives.	Salines.	Antacids.	Sulphides.
2 grs.	4-10th grs.	2-10th grs.	1-10th grs.	4-10th grs.

These results differ so much from the published analysis by M. Longchamp that we reproduce his here :—

Sulphuret of sodium	3·60
Sulphate of sodium	3·84
Chloride of sodium	3·07
Silica	5·19
Lime	0·22
Magnesia	0·26
Soda	0·39
Total solids	16·57

The relative strength of the waters of the low and high Pyrenees has been compiled from the analysis found in Dr. Candellé's book. They are all very similar in character to the Barèges waters, and it is only necessary to present to our readers the amount of sulphides to each, to give all necessary information :—

	Sulphides, grs. per gall.
Eaux Chaudes (*Source Baudot*) ...	·6
Barèges Le Tambour (*the strongest*)	3·0
Other sources, about	1·4
La Chapelle	1·4
Saint Sauveur	1·75
Cauterets, various sources, about ...	1·05
Amelie les Bains	1·4

We shall close our list of sulphur waters by—

Bonnes.

The Bonnes waters were examined in 1877 by Prof. Attfield, and we therefore give his results. It will be seen that these waters, according to that report, differ very much in character to any previous examination. In the antecedent waters the sulphuration was due either to sulphide of sodium or calcium.

In the water examined, it seems, according to the analysis, to owe its activity purely to the sulphide of hydrogen. Even if the water is active when taken at the source, it is evident that such a water is not suitable for bottling.

It contains per gallon—

	Grains.
Chloride of potassium	2·40
Chloride of sodium	17·59
Sulphate of sodium	2·86
Silicate of sodium	5·28
Sulphate of calcium	11·14
Magnesium (trace)	
Lithium (trace)	
Nitrates (trace)	
Phosphates (trace)	
Silica	1·02
	40·29

Sulphuretted hydrogen 1½ cubic inches per gallon.

Skeleton Analysis of ½ a pint (10 *ounces fluid*).

Total Solids.	Salines.	Antacids.	Purgatives.	Sulphides.
2½ gr.	1¼ gr.	·0	¼ gr.	9-10ths of a c. inch of H_2S.

CHAPTER XIV.

Therapeutics of Sulphur Waters.

The sickening smell of these waters is due to the sulphuretted hydrogen they give off, and to this gas has often been attributed their remedial efficacy. It has been shown, however, that the alkaline sulphides slowly evolve the same gas, and the waters which contain these bodies may claim to have the therapeutical value lately assigned to calcium sulphide. However doubtful may be the influence of medicinal doses of this salt, the waters which contain it have long held the highest place among sulphuretted waters, and their history is full of marvellous cures. Whether their future records will be as satisfactory, or whether their action will be more carefully studied, remains to be seen. Certain it is that a large number of able observers have lost faith in the majority of sulphur springs, and others have held that their effects are to be accounted for by their other constituents, or by the effect of baths, climate, and the complete change involved in a visit to the spas. On the other hand, it is held by many that the sulphur compound is the essential ingredient, and that it possesses extraordinary therapeutical powers. In

German medicine abdominal plethora plays an important part, and sulphur waters are believed to control this condition and to remove the "hæmorrhoidal diathesis." The largest group of sulphur baths is that of the Pyrenees, on the French side of which only there are 110 distinct resorts with about 500 springs.

The poisonous effects of sulphuretted hydrogen are well known, but are never observed from drinking the waters which are richest in the gas, although it is said that inhalation over the springs has to a very slight degree produced toxic symptoms. The favourite theory in Germany is that when the water is drunk the sulphuretted hydrogen passes directly into the blood of the portal vein, and there hastens the destruction of partly-used blood corpuscles by abstracting the iron. Thus the anæmia that succeeds full courses is accounted for as well as the blackening of the fæces which is constantly observed. Of course when iron is present in the water the last remark would not apply; but, when there is none, sulphide of iron has been found in the dark evacuations, and anæmia has been so marked as to render a course of chalybeates necessary. At the same time enlargement of the liver is decreased, and the symptoms of sluggish portal circulation disappear. Thus a considerable number of indications are explained, and in the same way the use of the waters in metallic poisoning is placed on a better foundation, for the liver is the part where the metals are mostly deposited, and the old notion of direct combination of metals and sulphur in the system was unsatisfactory, since most of the sulphides are insoluble.

It has been supposed that the alkaline sulphides are only effectual by liberating the gas in the system; but much may be said against this view. Recently there has been a

disposition to attach greater importance to these sulphides, and although the gas is frequently present in the intestinal canal it seems never to be absorbed. It is then scarcely to be expected that additional traces introduced into the stomach produce all the curative influence of the mineral waters containing them, while in cases of poisoning by sulphide of potassium the smell of sulphuretted hydrogen has been noticed in the breath. When prolonged baths are taken some of the escaping gas is necessarily inhaled, but the quantity must be small, or the effects would more frequently be observed. Sometimes, however, inhalations are systematically employed.

For drinking, the cold springs are at least as efficacious as the hot. Indeed, some of the most highly-charged waters are cold. They are reputed, in small doses, to increase the secretions of the alimentary canal. Some are aperient, others not. Most seem to stimulate tissue metamorphoses, and so reduce obesity, as well as abnormal swellings. Some exercise thus their chief effect on the chylopoietic viscera. Others act more on the skin. And others, again, claim to have a beneficial influence in diseases of the respiratory organs. No doubt all increase the action of the skin and kidneys.

We will now pass in review the therapeutics of the chief sulphur waters; the chemical characters of the majority have been described in the last chapter.

Harrogate.—Situated on a table-land rising from 300 to 400 feet above the sea-level, this famous resort has the advantage of a dry bracing climate, though it is rather cold in winter. There are good pump-rooms, and also excellent bath establishments. A visit to Harrogate is often more effectual than a season at a Continental spa. But it is with the water for drinking we have to do. It

keeps well, and is, therefore, adapted for bottling. There are numerous springs, but only a few are utilised. Sulphide of sodium and sulphuretted hydrogen are both found in the waters. They are associated with so much chloride of sodium that Harrogate may be fitly compared with salt spas. The waters, therefore, do not constipate—on the contrary, they are aperient. Moreover, they are not so likely to induce anæmia. Patients sometimes take them for a long time with distinct benefit. They seem to stimulate the abdominal viscera and promote tissue change. Dr. Myrtle thinks the aperient action less lowering than that of saline purgatives. From one to three weeks is the period for a course, but many have taken it much longer. It requires a pint to a pint and a-half to act as a purgative, and this is divided into three doses taken at intervals of a quarter or half-an-hour before breakfast. As an alterative, 2 to 8 ounces three times a day. As the sulphide of sodium amounts to 9-10ths of a grain per half-pint in the stronger springs, it will be seen that this substance is taken in appreciable doses. But with the sulphide the patient takes 63 grains (per half-pint) of solids, 4½ being distinct purgatives, and 2½ salines. If the stomach is delicate the water may be warmed. Harrogate is useful in dyspepsia and defective assimilation, as well as in functional disorders of the liver and abdominal congestions. Nervous affections, metallic poisonings, and syphilis are also said to be benefited. Skin diseases also form an important contingent of the cases treated at Harrogate with as much success as at any sulphur spa. The chalybeate waters of Harrogate have already been mentioned. The presence of the two gives the place a prominent position. The bottled waters may be taken as at the springs, either cold or warm, for two or three weeks, according to

the indications; but Harrogate is so accessible to our readers, and has such a tonic bracing climate, that it may more often be resorted to for a holiday by the invalids who need to try its waters.

Aix-la-Chapelle has not the attractions of Harrogate; it is, indeed, a dirty manufacturing town, and even the country around is not inviting. But its bathing establishments are very fine, and it may be regarded as the representative Spa of Germany. Hot baths, douches, and vapour baths are used, and the water is also drunk, but the great reliance is on the baths. All the elements of the thermal system, so much recommended in rheumatism, gout, and abdominal disorders, are combined at Aix. Scrofula and skin disorders are also treated here, and the place has been much exploited for syphilis, but in this disease iodide of potassium or mercurial inunction is always employed in conjunction with the baths, so that if the doctors have great faith in the waters they are also fully convinced of the power of these drugs. The waters are also employed in metallic poisoning, and even so judicious a writer as Dr. Lersch, who has been called "the father of balneology," expresses himself as satisfied that they are efficacious in improving the health of those who have suffered from the effects of mercury, and that they also tend to make latent syphilis manifest itself. The water is not nearly so much mineralised as that of Harrogate; it contains only 17¾ grains in the half-pint, only 0·04 gr. being sulphides.

Barèges, over 4,000 feet above the sea-level, offers a true mountain air, but the weather is very variable, and often too keen. It is in high repute for persons suffering from old wounds and for paralytics. In rheumatism, neuralgia, and bone diseases the baths are also recommended.

The accommodation is poor, and there are no attractions, save the waters, which are suitable for bottling, as the sulphurisation is due to sulphides (4-10ths gr. per half-pint).

Eaux-Bonnes, situated lower down, 2,300 feet above the sea-level, offers a less trying climate with better accommodation. There is, however, considerable variation of temperature, and visitors should be warmly clad. It is most frequented for throat and lung affections, and, besides the baths, there are inhaling-rooms. But the mineralisation of the water is so slight that its effects have long been attributed to some undiscovered cause, and some of the local physicians do not hesitate to give the climate most of the credit. One can readily suppose that benefit may accrue from mountain air combined with change of scenery occupation, diet, and regimen. Certainly chemistry reveals nothing to account for the beneficial effects so long attributed to this Spa. The water is not adapted for bottling.

Cauterets is 3,200 feet above the sea, and though the climate is rather variable it is in high repute for chronic bronchitis. Drinking the water is here in vogue, and it contains sulphide of sodium, but not more than 0·10 gr. in the half-pint. Some have supposed that the effect may be partly due to silica.

Bagnère de Luchon being only 2,000 feet above the sea has a much milder climate. It is rather changeable, but in the season fine weather may be expected. The bath establishments and other accommodation are far superior to those of the other Pyrennean Spas, and the waters are richer in mineral ingredients. The same cases are treated as at Barèges and Cauterets, in addition to which skin affections are said to be more benefited here.

Aix-les-Bains might very well be omitted from this

work, as the waters are but little used for drinking, and not adapted for exportation, as they are very weak; but the place has obtained such renown for its complete bathing arrangements as to be justly regarded as a most important sulphur spa. There is an abundant supply of hot water—a million gallons a day, at 112° to 114° Fahr. —so that baths and douches can be supplied without stint. Moreover, the steam from the springs is collected and employed for every form of vapour-bath. In fact, all the resources of this spa are so completely utilised that here every variety of thermal therapeutics may be carried out in perfection. As to drinking, the Aix waters are used to some extent; but when it is desired to fully subject the system to the influence of sulphur, advantage is taken of the proximity of Marlioz and of Challes. The establishment at Marlioz, only a short walk from Aix, is well conducted, and the inhalation rooms are in much request. The water from Challes, near Chambéry, is brought to Aix, and is a strong sulphur water, containing also iodides and bromides, and is specially rich in sulphide of sodium. There are also other waters in the neighbourhood. In fact, Aix-les-Bains may be regarded as the thermal capital of Savoy—a region rich in mineral waters. All those diseases in which thermal baths are indicated are treated at Aix, but perhaps it is in rheumatic affections that the waters are most valuable. Gout, sciatica, scrofula, affections of the nervous system and of the digestive organs are also benefited by a visit to Aix, where the climate, scenery, and other attractions of the place, no doubt, contribute to the restoration of the thousands of visitors who throng the place. It is often said that English people should avoid Aix in August; but personally I have not found it too hot in that month,

and in those severe rheumatic cases which are sensitive to cold there are several reasons for choosing that time for a course of the baths.

Allevard is situated nearly 1,500 feet above the sea level, and the climate is rather trying, but, on account its beautiful scenery and other attractions, is a good deal visited. The water is cold, and contains, in addition to sulphuretted hydrogen, more carbonic acid than Eaux-Bonnes. There is also an unusual proportion of nitrogen. Inhalations of the gases, both warm and cold, are employed. The waters are in repute for all cases in which sulphurated springs are employed, but most in affections of the respiratory organs, in which one would think the climate demands that the cases should be carefully selected.

Switzerland, *Italy*, and *Spain* have numerous sulphur springs, both cold and warm, but the waters are mostly used at the spas ; and our work having chiefly to do with bottled waters, we must pass them by.

CHAPTER XV.

Chemistry of Special Waters.

Kreuznach.

The Kreuznach is one of the most important waters in Germany as a medicinal water, owing to the large quantity of iodine and bromine present.

The Elisenquelle spring contains grains per gallon—

Chloride of sodium	728·83
Chloride of calcium	133·89
Chloride of magnesium	40·71
Chloride of potassium	6·24
Chloride of lithium	6·13
Bromide of magnesium	2·78
Iodide of magnesium	0·35
Carbonate of calcium	16·93
Carbonate of baryta	0·10
Carbonate of magnesia	1·06
Carbonate of protoxide of iron ...	1·50
Silica	1·29
Phosphate of aluminium ...	0·25
Total solids ...	940·06

Skeleton Analysis of ½ a pint (10 *ounces fluid*).

Total Solids.	Salines.	Antacids.	Purgatives.	Iodine.	Bromine.
58¾ grs.	46	1¼	2½	0·019	0·15

Chloride of Lithium.

⅓ grain.

The above is Lowig's analysis converted into grains per gallon.

Luhatschowitz.

The Luhatschowitz springs in Moravia are peculiar in containing very large quantities of iodine and bromine.

The analysis of Vincenzbrunnen gives—

Carbonate of sodium	232·63
Chloride of sodium	235·27
Bromide of sodium	2·55
Iodide of sodium	1·32
Carbonate of lithium	0 09
Carbonate of magnesium... ...	4·22
Carbonate of barium	0·70
Carbonate of calcium	46·84
Carbonate of strontium	0·93
Carbonate of protoxide of iron ...	1·11
Chloride of potassium	17·95
Silica	3·95
Total solids ...	547·56 grs.

Skeleton Analysis of ½ a pint (10 *ounces fluid*).

Total Solids.	Antacids.	Salines.	Purgatives.	Iodine.	Bromine.
34½ grs.	18	16½	0	·06	0·86

The reaction with phenol-phtalein was well marked in the cold, and permanent. This water is said to be the strongest alkaline water known.

Teplitz.

The town of Teplitz abounds in mineral springs, of which the Hauptquelle is, perhaps, the most important. It springs from the ground, at a temperature of 120° Fahr. It is peculiar in containing about 1-100th part of its total solids, as iodide of potassium; and when used xternally, these hot Teplitz springs produce a very marked effect, frequently resulting in fever symptoms and cutaneous eruptions. The cold springs do not produce these effects.

	Grains per gallon.
Sulphate of potash	4·3
Carbonate of soda	26·8
Carbonate of lithium	0·1
Carbonate of lime	3·2
Carbonate of strontia	0·1
Carbonate of magnesium	0·8
Carbonate of maganese	0·5
Carbonate of iron	0·3
Chloride of sodium	4·3
Chloride of potassium	1·0
Iodide of potassium	0·5
Phosphate of aluminium	0·2
Silico-fluoride of sodium	0·3
Silica	3·1
Crenic acid	0·9
Total solids	46·4

The above analysis is taken from Dr. Madden's "Spas."

Skeleton Analysis, ½ pint (10 ounces fluid).

Total solids.	Antacids.	Salines.	Purgatives.	Iodine.
3 gr.	2 gr.	¼ gr.	⅓ gr.	·0023

Woodhall.

Woodhall seems to be a powerful iodized spring ; it also contains a very considerable quantity of arsenic. The following results are published from Dr. Frankland's figures :—

	Grains per gallon.
Total solids in solution ...	1652·84
Organic carbon	0·2604
Organic nitrogen	0·3724
Ammonia	0·5070
Nitrogen as nitrates and nitrites	0·0063
Chlorine	997·5000
Total combined nitrogen ...	0·8456
Iodine	0·6160
Arsenium	0·0112

As Dr. Frankland's figures carry some authority with them, we have given his analysis, although not very complete. We were not able to get hold of this water, or to get much information thereon ; but we should say that it is probably more of a geological curiosity, than of any practical use. The presence of such a large quantity of organic nitrogen is objectionable, without there is some special explanation of its origin.

Lisdoonvarna.

Of Irish mineral waters the most important are at Lisdoonvarna and Lucan. As regards Lisdoonvarna, according to information supplied by Dr. Stacpool Westropp, this district is full of mineral springs which have never been analysed, and even those that have been examined require periodic re-examination. They were first analysed by Dr. Apjohn, and also, about six years ago, by Messrs. Studdart and Plunket.

There are three chalybeate springs, which, according to Dr. Apjohn, contain iron in the relative proportions of 100, 73, 59. There are also sulphur springs: we have, however, no evidence as regards their stability or constancy. The last analyses proved the presence of lithium in the sulphur springs, and manganese in the iron.

Dr. Westropp possesses a considerable amount of information upon the general composition of these waters which has not been published; but, unfortunately, they cannot be procured in commerce, as they are not bottled. Here we have one of the many thousands of industrial resources of Ireland, which, from some cause or other, remain dormant. If even a second-rate mineral spring is discovered in Germany, a company is immediately started for its development—sometimes with English and French capital. The Irish springs remain without an attempt being made for their commercial introduction. We have no doubt that at Lisdoonvarna we have a district that will prove as rich and fertile in mineral springs as Harrogate itself. There are also said to be springs at Lucan of great purity and value. Dr. Reynolds has lately analysed one of them, which established it as a powerful alkaline sulphur spring. The same remarks apply to this water, and as, from inquiries, there is very little probability of seeing these waters in the hands of the consumer, we are compelled to pass over them without giving analyses. With every wish to give encouragement to native products, our work does not deal with watering resorts, however desirable they may be. If we have, however, drawn attention to the want of energy existing in connection therewith, we have not thrown away the space devoted to Lisdoonvarna and Lucan.

CHAPTER XVI.

THERAPEUTICS OF SPECIAL WATERS.

Springs containing iodides and bromides have naturally attracted attention, but these substances have been found only in such minute quantities that we may well hesitate to ascribe to them the effects of drinking the waters. Moreover, they do not occur alone, but are always associated with a large amount of chloride of sodium, to which many of the effects are obviously due. The old name of salt waters, or brines, is, therefore, still an appropriate designation. Some waters containing a little salt have been already considered in the account of table waters; others, where the quantity is larger but associated with sulphates, are classed with purgative waters. There remain the salt waters with their minute quantities of iodides and bromides. The strongest of these waters in full doses do not enable us to administer to an adult more than about half-a-grain of bromides or a quarter of iodides daily; and as we must give at the same time large doses of chloride of sodium, which possesses marked physiological properties, it is but natural to ascribe to it much of the therapeutical effect of the remedy.

As soon as salt, in moderate doses, is introduced into the stomach it increases secretion, and soon after stimulates more rapid absorption, thus producing thirst. Large doses are emetic, and, unless vomiting take place speedily, will pass off by purgation; but the influence of small and moderate doses on the bowels is indirect. In small quantities salt plays an important part in the solution of albumen and starch, whence partly its repute as a digestive. Then it is necessary as a constituent of the blood; and as it is continually being employed in secretion and tissue metamorphosis, it must be supplied afresh, or the store previously laid up drawn upon. Further, urea is so constantly accompanied by a relative proportion of salt that the one has been proposed as a measure of the other. The excretion of urea is increased in proportion to the increase of salt supplied to the blood, the elimination of the chloride being also proportionately increased. This increase of urea, however, is not detected at first, but begins later than the salt, which is often nearly all removed before the urea has reached its maximum. Although salt stimulates tissue changes, it does not appear to cause emaciation, but rather to improve nutrition, unless administered in such quantities as to derange digestion and cause purgation. The effect in the *primæ viæ*, as we have already seen, is to assist digestion and so promote appetite or increased nutrition.

From what has preceded it will be seen that salt is a most important agent for its effects in the alimentary canal, as well as in the blood and tissues; but when administered in mineral waters, we have to remember certain modifying influences. These are—the strength of the water, the temperature at which it is taken, the carbonic acid and other ingredients. These points have been dis-

cussed in regard to waters in general, and the application of the principles laid down will be readily seen.

It is in diseases of the chylopoietic system that salt waters are most in repute, but they are also highly esteemed by some in gout, scrofula, and other conditions. We are, indeed, entertained by guide-books with tales of fibroids being absorbed, and greater wonders still, under the influence of some of these waters. Well would it be for the public if they would only listen to the voice of rational medicine instead of giving credence to the fables of the ignorant. We have now only to particularise a few salt waters.

Kreuznach enjoys a high reputation in scrofula, and some have supposed that the iodine it contains may exercise a beneficial effect in this diathesis. On reference to the analysis it will be seen how small is the quantity of this metalloid—only 0·019 of a grain in half-a-pint. Chloride of calcium, which has been much esteemed in scrofula, is present in appreciable proportion (see p. 186) —over eight grains per half-pint. In adults the dose of the water to begin with is 4 ozs., gradually increased to 20 or even 30 ozs. We attribute much of the effect of Kreuznach to the systematic use made of the baths, to which is pretty constantly added the mother-lye—"a clear, yellowish-brown, oily liquid" (*a*)—which forms the residuum after the crystallisation of the common salt. Such brine and lye baths might, no doubt, be well carried out at Droitwich, and other places where brine wells exist.

Luhatschowitz cannot be regarded as merely a salt water, for it contains about as much carbonate as chloride

(*a*) "Mineral Waters of Kreuznach." By Edward Stabel, M.D.

of sodium (see p. 187), and is, therefore, a powerful alkaline water, in which we have also to reckon on the effects of the salt.

Teplitz is scarcely for drinking. We regard it rather as a typical bathing spa, of the kind often called indifferent, and attribute its value in rheumatism, gout, and other diseases to the thermal baths which are systematically employed. The water is above 100 deg. Fahr., and the effects of well-regulated warm baths are to be obtained wherever the springs have a sufficient temperature, and are judiciously used. The water is also feebly alkaline. (See analysis, p. 188.)

Woodhall claims to be the strongest iodised spa. We have seen how small a quantity of iodine it contains—only 0·6160 of a grain in a gallon (p. 189), and that in conjunction with more than 1,600 grains of other solids. It is recommended in gouty and rheumatic affections of long standing. Its very salt, not to say briny, taste is much against it.

Wiesbaden is one of the most important thermal salt spas. The waters are drunk as well as used in baths, but it is the external use which is most active. In gout and gouty indigestion these waters are highly valued. The several springs contain from 24 to 30 grains of salt in the half-pint; and the hottest has a temperature of 156 deg. Fahr., with only three cubic inches of carbonic acid.

Kissingen may be advantageously contrasted with Wiesbaden, for although the amount of salt is not much different in these two, the temperature of Kissingen is much lower—only 51 deg. Fahr.—and it contains seven times as much gas as the hotter spring. It is in diseases of the digestive organs that Kissingen is most useful, though it is also resorted to for nervous affections.

Bourbonne-les-Bains is the French Wiesbaden. The waters have a temperature of from 114 to 140 deg. Fahr. —quite warm enough for all purposes.

Wildegg and *Durkheim.*—The waters of both these contain a good deal of lime and little gas. They, consequently, sit heavy on the stomach, and are not suitable for exporting.

Nauheim.—The springs are so rich in salt that it can be profitably obtained for commerce. The temperature is 83 to 100 deg. Fahr., so that *hot* brine baths can always be had here. There is also a good deal of carbonic acid, and some springs are used for drinking. When only brine baths are needed it is easier to resort to

Droitwich, where the brine is many times stronger than sea-water. It is only adapted for external use. It is a cold spring, but the baths are kept artificially warmed ; and Dr. Bainbrigge has found them very successful in chronic rheumatism and gout, as well as in other diseases, since he has conducted the establishment.

CHAPTER XVII.

Artificial Mineral Waters.

It may now, perhaps, be desirable to say a few words upon artificial mineral waters, particularly as regards those artificial aërated waters which are used medicinally, and are, or are supposed to be, made according to the formulæ of the Pharmacopœia.

The artificial mineral water trade may be divided into three groups:—

1. Beverages constructed upon original private formulæ and used as substitutes for wines, beers, &c.

2. Imitation of mineral springs.

3. Medicinal waters, the formulæ of which are in the Pharmacopœia.

As regards the first, namely, those that are used for beverages, we have very little to say. We should at once state that, as a rule, they are turned out fairly wholesome in this country by the respectable manufacturers. The chief ones in use in the British Isles are lemonade, ginger beer, and ginger ale. The lemonade is made by the best houses from citric acid, sugar, flavoured with essential oil of lemon, and is strongly aërated with carbonic acid gas. Nothing else should go into the preparation sold under

that name. The ginger beer is a somewhat similar preparation, but is probably more wholesome for general drinking. It is not, as a rule, made so sweet or so acid and besides, contains a little essence of ginger, which renders it stomachic.

These preparations generally contain small quantities of alcohol.

In many of the ginger beers tartaric acid is substituted for citric, and capsicums are frequently substituted for ginger, not so much as an adulteration as from the fact that the heat gives a fanciful idea of strength, and the flavour of capsicums is more permanent than ginger. The practice is not, however, to be commended. "Ginger ale" is a stronger preparation, generally much more highly flavoured with lemon and orange oils, and containing larger quantities of capsicum. It was invented to satisfy the coarser palate of the public-house drinker, or where alcoholic beverages have destroyed the delicate perception of the palate. The more refined flavour of good-made "lemonade" or ginger-beer produce no sensation, and go for nothing with the ardent disciple of Bacchus.

Probably ginger ale fulfils the requirements of a certain class of consumers, on the principle that all popular things must have their call. This is the most that can be said in its favour. The practice of substituting tartaric acid for citric is merely a matter of economy—it not only goes further being a stronger acid, but it is cheaper. Owing to the more insoluble character of tartrates, and their more corrosive action as compared with citrates, such a practice should be discouraged in a beverage which is in constant use.

There are besides the above-named beverages, a

class of compounds containing bodies selected for their well-known therapeutic action, and introduced to the public under some such fanciful name as life-giver, but scientifically turned into Greek. Some of them have a German sound, as if they had emanated from our Alemanian friends. We have no objection to such every-day drinks so that we know the composition, at any rate as far as their active ingredients. We refer to such ingredients as phosphate of iron, salicylate of soda, &c. Some years ago a great outcry was raised against artificially prepared aërated waters, lead having been discovered in some of them. It was generally found in bottled waters of the class of which we have been speaking. Most of the large manufacturers adopted electro-plated cylinders, gutta-percha pipes, with numerous other devices to avoid this impurity. But both the analysts and public seemed to be oblivious to the fact that the citric acid of that day was largely contaminated with lead, as the acid was crystallised in leaden pans. This practice should be discarded by every manufacturer who respects his position. We have examined many samples, and are quite certain that the most respectable manufacturers send out their mineral waters free from such a contamination.

The second class of artificial waters are those in which an attempt is made to imitate the natural springs. When we consider mineral waters from a medical aspect we cannot too strongly condemn such an attempt. Our opinion has been throughout this work pretty broadly expressed. There are two very good reasons why mineral waters cannot be copied artificially. The ultimate analytical result does not represent the actual grouping of the elements as they originally existed in the water; at the best it is but a scientific, or theoretical grouping, which in a

few of the elements may be very wide of the mark. Under these circumstances the analysis, is only an approximation. This does not, however, deteriorate from the value of a reliable analysis for the purposes of general classification and knowledge of the waters' position amongst its congeners.

he analysis of a mineral water means a study, our intimate knowledge of which increases with each examination. On the most modest computation it should be at least yearly. How is an artificial mineral-water maker able to follow this study, or is he likely to do so? Let us take a look at some of Fresenius and Bunsen's analyses performed on large quantities of the waters and on the spot to realise the absurdity of such an idea.

How much more likely that the imitation of mineral springs will degenerate into preparations which go by the same name but have not the slightest connection in composition. The Seidlitz water—an aperient water entirely inorganic, or mineral in its origin—owes its activity to sulphates of magnesia and soda, with an antacid reaction due to alkaline earths, iron, and many other ingredients. The "seidlitz" powders consist of tartrate of soda and potash.

The Seltzer spring consists of at least seventeen compound bodies, is a mild saline of a complicated nature, and chiefly consisting of sodium carbonate, magnesium chloride, and magnesium carbonate. It is generally represented by a beverage made with salt and aërated water. Sometimes Epsom salts are substituted for the common salt. To such results would all come if the public had sufficient confidence in artificial mineral waters to induce a demand. Let us hope that we shall never arrive at such a stage; rather let us not use them at all, than foster a trade which could never be conscientiously carried out.

The third class of mineral aërated waters constitute an important number of pharmacopœial remedies, and the first of them is perhaps the most important.

Liquor Lithiæ Effervescens (Lithia Water).

This preparation should be made, according to the Pharmacopœia, by dissolving five grains of carbonate of lithia in the half-pint of water, using carbonic acid gas at a pressure of seven atmospheres (about 105° to the square inch). Now, although this pressure may be rather superfluous, it is evident that the amount of lithium should be present in the water. We are sorry to say that, from our examination of the lithium waters in commerce that they are sadly deficient in this respect; in fact, in one case no lithium whatever was present. As the lithium salts are now comparatively cheap, owing to the large finds of lepidolite and petalite, there is no excuse for this fraud. A curious observation made is the fact that lithium is often introduced into lithia waters by employing the chloride of that base—in other words, that it is a chloride of lithium plus aërated water. Now, as carbonate of lithium is soluble in water itself to the extent of three or four grains per ounce without the intervention of carbonic acid, this is passing strange. It probably crept in from the use, in the first instance, of lithium of an impure character. Impure carbonate of lithium is largely adulterated with calcium carbonate even to the present day. The latter is often found as a commercial impurity of the salt, and the author also found barium carbonates present in one sample. There should be no difficulty presented to the intelligent manufacturer in making lithium water according to the Pharmacopœia, and as it is never used except

in failing health, we should particularly recommend this article to the consideration of the inspectors under the Adulteration Act.

It is probable that the list of medicated aërated waters in this direction might with advantage be extended; thus, preparations of benzoate and guaiacate of lithium might be added to the list.

Liquor Magnesiæ Carbonatis (*Fluid Magnesia*).

This preparation, although not generally classed as a mineral aërated water, will, on a little consideration, be seen to be made upon the same lines. It was originally introduced to the profession by a well-known physician in his day, Sir James Murray, of Dublin. He brought it out as a patent, or proprietary medicine, many years ago. After gaining great popularity under the name of fluid magnesia, its celebrity rather declined, owing to the fact that it deposited crystals of magnesium carbonate. The original preparation was made by suspending carbonate of magnesia in water in a tub, or suitable vessel, and passing carbonic acid gas through it until it dissolved. The solution was then allowed to settle, and the clear supernatant fluid poured, or drawn off for use. As thus made, it contained a very little excess of gas, and therefore soon deposited the crystals of magnesium carbonate. Sir James Murray, many years after its first introduction, patented a fresh process, by which, after pouring off the bright fluid, it was re-aërated under considerable pressure. This seems to be the process of the Pharmacopœia. In that book we are directed to make a moist carbonate of magnesium by precipitating Epsom salts with carbonate of soda, and then to pass an excess of carbonic acid gas through it for 24

hours. The resulting fluid is directed to be filtered, and then re-charged with gas. It will be seen that such a process amounts to the production of an aërated water, and is, in fact, Sir James Murray's patented re-carbonated process.

As the fluid magnesia is in the hands of two or three manufacturers of acknowledged celebrity, we generally get the right thing. It might be more strongly aërated, however. It should contain 13 grains to the fluid ounce. The strength could be reduced to 10 grains with advantage, and would make a more permanent preparation.

Liquor Potassæ Effervescens (Kali Water.)

A valuable water, containing, according to the Pharmacopœia, 30 grains to the pint of bicarbonate of potassium. Although so easily made, it has been found very varying in quality. Kali water is not much used, and is probably made carelessly by the manufacturer. As it is one of the most active of the antacid waters, it should be of a uniform strength. We never recollect having examined, however, any kali water that did not contain something near the quantity.

Soda Water.

Soda, of all the aërated waters, is the most generally consumed, and, therefore, may be considered the most important. There are certain requirements which must be met, and the desire for a well-marked antacid and carbonated drink is hit off in soda water. Soda is perhaps naturally selected by the stomach, and probably with advantage, as it is the alkali which of all others is least likely

to derange the animal system. The large amount of that substance in the human body, which may be roughly calculated at 0·5 per cent. of all the fluid constituents, could not be much influenced even by the constant use of soda water.

Liquor Sodæ Effervescens, the soda water of the Pharmacopœia, is rather a strong preparation, containing 30 grains to the pint. If we might judge of the results from what we find in commerce, it is considered too strong, for in no case could you get anything approaching this strength. Instead of 30 grains we find the most erratic confusion upon the subject of soda water. A few selected analyses of samples analysed will illustrate this more aptly than any discourse upon our part.

	Grains per 10 oz., or ½ pint.
A. B.P., from a respectable manufacturer sending it out under that brand ...	13¾
B. No sodium bicarbonate was present in this sample, it being aërated water, and the solid proceedings from the water used (chiefly lime salts) ...	3½
C. Sulphate of sodium, 10 ; bicarbonate of sodium, none	10
D. Sulphate of sodium, 5 ; bicarbonate of sodium, 4	9
E. Bicarbonate of sodium	5

The use of sulphate of sodium is peculiar, and although such a preparation may be called a "soda water," it is

not what is generally accepted as the ordinary effervescent preparation which goes under that name. We presume that a certain class of drinkers, when they require an early morning draught, wish for something more aperient than the antacid liq. sodæ effervescens of the Pharmacopœia. In the sample "D" we find the two judiciously blended, whilst in "B" it is probable that the water was too hard to allow of the use of bicarbonate of soda. "E" is a striking example of the uncertainty of strength found amongst the commercial preparations. Some houses send out as many as five strengths.

I find the B.P. preparation is like all waters which contain a considerable excess of soda, a little "soapy" in its taste, and it is just probable that this is one of the causes which induce the manufacturer to diverge from the recognised standard.

The general divergence observed in an article which is supposed to have a definite preparation, and which is frequently recommended by the physicians, is disgraceful in the extreme, and certainly something should be done to regulate the chaos exhibited by this preparation. Every manufacturer should definitely state upon the label the amount of sodium bicarbonate contained in his preparation.

Carrara Water,

So named from the springs in the marble district of North Italy, is now understood to be a saturated solution of carbonate of calcium in aërated water. There is hardly any demand for this water, therefore it calls for no remark.

The most important point about artificial mineral

waters, however, is the quality of the water from which they are manufactured. We have no doubt that a large manufacturer's important considerations are—first, is my water pure? secondly, is it sufficiently soft to enable me to use it with advantage? This is as it should be; but we have to take into consideration that at the present day in almost every unimportant town there is a local man who starts to manufacture mineral waters because circumstances call for his action, and because "it pays," in nine of such cases out of ten, he becomes a *disseminator of poisonous water*—sometimes so bad that the flavouring material alone hides a quality which in its impure, but simple state would be unbearable.

CHAPTER XVIII.

THE MINERAL WATERS OF EUROPE CLASSIFIED ACCORDING TO THEIR CHIEF CHEMICAL AND THERAPEUTICAL ACTION.

Abbreviations.—T., temperature ; A., altitude ; IMP., Imported into British Isles ; LOC., Locality.

ALKALINE, AND ANTACID WATERS.

Class 1.

BATH, England.—T. 116°. Gaseous.

BUXTON, England.—T. 82°. Slightly ferruginous. See also Table Waters for new analysis.

CHATELDON, Puy-de-Dome, France.—Very gaseous. and chiefly alkaline earthy carbonates. There is an establishment. IMP.

CHATEAUNEUF, short distance from Riom, France.—Mixed carbonates of potash and soda. Four establishments. T. 60° to 95°.

CONDILLAC, Vaucluse, France.—A very gaseous water, chiefly calcic carbonate. IMP.

COUZAN, France.—Very gaseous. IMP.

EMS.—Kranchen and Kesselbrunnen. See analyses (Tichborne), p. 92. IMP.

GEILNAU, Germany.—Mild alkaline water. IMP.

GIESSHUBLER, Bohemia.—IMP.

LIPPSPRINGE, Westphalia.—A. 378′. Alkaline earths. IMP.

MEDAGUES, Central France.—A strong water containing nearly equal portions of carbonate of calcium and carbonate of sodium with chloride of sodium.

NEUENAHR, Rhenish Prussia.—A. 225. Gaseous. IMP.

SALZBRUNN, Silesia.—A. 1215. IMP.

SAINT PARIZE.—T. cold. Chiefly consists of calcium carbonate and sulphate.

SCHLANGENBAD, Nassau.—A. 900. Mild alkaline waters, gaseous. Said to have a special action upon the skin in the form of baths. Contains magnesia. IMP.

SODEN, Nassau.—A. 450. Gaseous and slightly ferruginous. Soden has a beautiful climate, and is beautifully situated. It is extensively resorted to in tubercular diathesis from this reason. IMP.

SOULTZMATT, Haut-Rhin.—A. 850. Gaseous. IMP.

VALS, *Desiree.*—See analyses (Tichborne), p. 86; (Ossian, Henry,) p. 86. St. Jean, see analyses (Tichborne), p. 87. IMP.

VIC LE COMTE.—T. 60° to 90° Faht. Equal quantity of sodium, carbonate and chloride. A strong water.

Class 2.—Containing Small Quantities of Arsenic.

VICHY GRAND GRILLE.—See analysis (Tichborne), p. 78.

VICHY HAUTERIVE.—See analysis (Tichborne), p. 79.
VICHY MESDAMES „ „ p. 80.
VICHY HOPITAL „ „ p. 81.
VICHY PARC „ „ p. 82.

All the Vichy Waters contain considerable traces of arsenic, are ferruginous, and also contain large quantities of the alkaline earths. They are classed under the head of Bicarbonatees Sodique by Candellé, and are all imported.

Class 3.—*Containing Lithium.*

BILIN.—See analyses (Tichborne), p. 89. IMP.

VICHY GRAND GRILLE.—See Alkaline Waters containing Arsenic.

VALS PRECIEUSE.—See analyses (Tichborne), p. 85. IMP.

WILDUNGEN.—A. 300. Earthy character; ferruginous. IMP.

ARSENICAL WATERS.

Class 1.—*Arsenic occurring as Arsenic Acid.*

LE BOULOU.—See Chalybeate Waters.

COURT ST. ETIENNE.—See analysis (Tichborne), p. 107; (De Wilde), p. 107. IMP.

PLOMBIERES, LOC., the station is Aillevilliers, on the Chaumont Line, France.—T. 50° to 158° Faht. There are six establishments. IMP.

SAINT-NECTAIRE, LOC., Issoire, France.—Numerous sources, and four or five establishments. A. 784 metres.

These are weak arsenicals with strongly alkaline characters.

VALS, DOMINIQUE.—See analyses (Tichborne), p. 87 and p. 88.

WIESBADEN.—See Chalybeate Waters, p. 154.

ROYAT.—See Chalybeate Waters, p. 157.

Class 2.—*Arsenic occurring as Arsenious Acid.*

LA BOURBOULE, LOC., Puy de Dome, France.—A. 2600. T. ranges from 69 to 120° Faht. See analyses, &c. (Tichborne), p. 106.

CHALYBEATE WATERS.

Class 1.—*Strong.*

ALET, a short distance from Carcassonne, in France.—Not of much importance. Contains the iron in the ferrous condition. IMP.

ALEXANDERBAD, Bavaria.—A. 1754.

ALEXISBAD, Germany.—A very strong water. Three sources.

ALTWASSER, Silesia.—A. 1255. Two sources. Gaseous, and used extensively for baths.

AUTEUIL.—An old watering-place in the neighbourhood of Paris used by the bourgeois. IMP.

BRIGHTON, England.—Cold.

BOCKLET, a short distance from Kissingen, in Bavaria.—Cold, strong, chalybeate; very gaseous. A. 620′.

BUSSANG, Vosges, France.—Contains the greater part of the iron, as crenate of iron and manganese. IMP.

DRIBURG, Westphalia.—A. 633′. Establishment. IMP.

Dorton, Buckinghamshire.—Very strong; containing 96 grains sulphate of iron per gallon.

Forges-sur-Briis, a short distance from Limours.—A cold chalybeate. The establishment contains an hospital for children.

Flitwick, Loc., Ampthill, Beds.—Aperient.

Gilsland, Cumberland.—Also said to possess a sulphurous water.

Harrogate.—Chloride of iron spring (Thorp), p. 156.

Homburg.—A. 600. See analyses (Tichborne), p. 152 (Liebig) p. 152. Imp.

Luxeuil, Jura Mountains.—T. 75° to 125°.

Passy, near Paris.—Four sources. Said to contain sulphate of iron. Very strong, and only used internally, with caution. When so given the water is allowed to stand some time, to deposit the greater part of the iron. Imp.

Pyrmont.—A. 400′. For analyses of the Trinkbrunnen (Tichborne) see p. 160. Two sources. Imp.

Rippoldsau, Baden.—A. 1886.

Sainte-Marie-du-Cantal, Saint Flour, France.—Strong ferrous, and carbonated water.

Sandrock, Isle of Wight.—Aluminous and gaseous. Chiefly used for baths.

Schwalbach, Nassau.—A. 909. Two waters imported—Weinbrunnen and Stahlbrunnen. Containing manganese, boracic acid, and a trace of sulphuretted hydrogen.

Shelfanger.—See analysis (Tichborne), p. 161.

Class 2.—Mild.

Boscombe, Loc., Bournmouth.—Contains 4 grains iron to the gallon.

CHARLOTTEN-BRUNNEN, Silesia.—A. 1437′.

CHELTENHAM, England.—Cold. There are several sources, which have different names. Thus, one is called "Saline Aperient;" another "Iodurettted and Sulphuretted Chalybeate," "Iodurettted Saline," "Pure Saline," "Iodurettted Magnesium Saline." All gaseous.

HARROGATE KISSINGEN, Attfield.—See p. 133.

HASTINGS, Sussex.

KISSINGEN, Bavaria.—(Tichborne), p. 134. A. 600′. IMP.

KOSEN, Saxony.—T. 65°.

LE BOULOU, Pyrenees, France.—The iron exists in the ferrous condition, and it contains a large quantity of carbonate and chloride of sodium. It is arsenical. Four sources. T. 59° to 68°.

LISDOONVARNA, Ireland.—Three iron springs of different strengths. See p. 187.

MEINBERG, Germany.—A. 634. Six sources.

MARCOLS, near Privas, France.—A cold ferrous spring, the iron is associated with acid carbonate of sodium. IMP.

MATLOCK, Derbyshire.—A very mild chalybeate.

MELKSHAM.—Artificially aerated and bottled.

MOFFAT.—Strong chalybeate.

OREZZA.—See Table Waters.

POUGES, on the line from Paris to Nevers.—Two establishments, which are very celebrated. Contains about 1½ grains of iron to the gallon in the ferrous condition. It is slightly laxative. IMP.

ROISDORF, Stahlquelle and Trinkquelle.—A. 1000 See analysis (Bischof), p. 151. IMP.

RECOARO, Venetia.—A. 1465. IMP.

ROYAT.—A. 1380. Eugenie. See analysis (Candellé), p. 158.

ST. MARK.—See analysis (Tichborne), p. 159. IMP.

SAINT ALBAN, near Roanne, France.—T. 17°.

SCHWALHEIM.—See Table Waters.

SPA.—A. 1030'. See analysis (Tichborne), p. 153. IMP.

TUNBRIDGE, England.—T. cold.

WIESBADEN.—A. 346. See analysis (Fresenius), p. 154 IMP.

IODIDE AND BROMIDE WATERS.

AIX-LA-CHAPELLE.—See Sulphur Waters.

ARNSTADT, LOC., ten miles from Erfurt, in Germany.—A. 926. A bromine water.

BRIDES.—See Mild Purgative Waters.

BOURBONNE-LES-BAINS contains iodine, casium, and rubidium.

CHELTENHAM.—See Chalybeate Waters, Class 2.

HALL, Austria.—A. 1700. IMP.

KRANKENHEIL, Bavaria.—A. 2467. IMP.

KREUZNACH, Germany. — A. 285. See analysis (Lowig), p. 184. IMP.

LUHATSCHOWITZ, Vinenzbrunnen, Moravia.—A. 1700. See analysis (Ferstl), p. 185.

PURTON, Wiltshire.—Contains both iodine and bromine. Aperient and gaseous. Bottled.

SAXON, Switzerland.—A. 1000. T. 80°. IMP.

TEPLITZ.—See analysis (Seegen), p. 186. A. 648 IMP.

WIESBADEN.—See Chalybeate Waters.

WILDEGG, Switzerland.—Almost used entirely for exporting. Very strong water, slightly ferruginous, inclined to produce iodism, but very active.

WOODHALL, England.—See analysis, p. 187.

SPECIAL WATERS.

HARROGATE.—Alum Well. (Davis), p. 171.

REICHENHALL.—A. 1407. T. 54° to 64°. Used for baths. Contains a large quantity of chloride of sodium and ammonium with bromine.

TCHITLI, Turkey.—A strong carbonate of soda spring. IMP.

WIESBADEN.—See analyses (Fresenius) p. 154.

LITHIA WATERS.

KISSINGEN, Bavaria.—See Chalybeate Waters.

BRIXTON.—Contains a trace of lithium. See Table Waters, Class 3.

FRENZENBAD.—See Purgative Waters.

Although lithia is very generally diffused, there are not many waters that warrant us in classifying them under the head of lithia waters.

See under the head of Alkaline Waters, BILIN, VICHY, GRAND GRILLE, VALS PRECIEUSE, WILDUNGEN, also

BADEN-BADEN.—See analysis, p. 139

BRIXTON.—Table Waters, Class 3.

FRANZENBAD.—See Purgative Water.

KISSINGEN, Bavaria.

WEILBACH, Nassau.—Weak sulphur. IMP.

PURGATIVES.

Class 1.—*Strong, containing Sulphates of Magnesia and Sodium, with slight Alkaline reactions.*

ÆSCULAP BITTER WATER.—See analysis (Tichborne), p. 49. IMP.

FRIEDRICHSHALL.—A. 920′. See analyses (Liebig), p. 33, (Tichborne), p. 33. IMP.

HUNYADI JANOS, Buda.—See analysis (Tichborne), p. 37. IMP.

MATTONI'S ROYAL HUNGARIAN WATER.—See analysis (Tichborne), p. 50. IMP.

PULLNA.—See analysis (Tichborne), p. 35. IMP.

RAKOCZA, Buda, Ofen. — See analysis (Tichborne), p. 36. IMP.

SEIDLITZ WATER.—See analysis (Steinman), p. 45. IMP.

SAIDSCHUTZ WATER.—See analysis (Berzelius), p. 45. IMP.

Class 2.—*Strong Purgative Waters, containing no Sulphate of Magnesium.*

MARIENBAD-FERDINANDSBRUNNEN. — See analysis (Tichborne), p. 39. IMP.

MARIENBAD-KREUZBRUNNEN. — See analysis (Tichborne), p. 40. IMP.

PORRETTA, Campagno, Italy.—Sulphurous. T., p. 86.

SALINS DE JURA, on the Paris and Lyons Railway.—T. 62°. Very strong purgative.

Sub-section 2.—*Mild Purgative Waters containing no Sulphate of Magnesium.*

PFEFFERS.—In use since 1038. T. 99°.

Class 3.—*Purgatives with strongly-marked Alkaline reactions.*

CARLSBAD-SPRUDEL.—See analysis (Tichborne), p. 42. IMP.

CARLSBAD-SCHLOSSBRUNNEN. — See analysis (Tichborne), p. 42. IMP.

CUSSET, France.—Five sources.

FRENZENSBAD.—A. 1500. Contains traces of iron and lithia. IMP.

ISCHIA.—There are several waters on this island, and a fine establishment at Casamissiola. The Aqua di Bagno Fresco is an alkaline water used by the ladies for rendering the skin white and soft. T. 160°

KINGSWOOD, Gloucestershire.—A bitter water, and gaseous.

Class 4.—*Purgative Waters, Strong, with Alkaline Earths.*

BIRMENSDORF. — See analyses (Tichborne), p. 46, (Bolley), p. 47. IMP.

CHATELGUYON, near Riom.—Ferruginous.

FILEY, Yorkshire.—A saline aperient, with sulphate of magnesia and calcium salts.

HAIL-WESTON, Loc., Hunts, England.

MERGENTHEIM, Wurtemburgh.—A. 591. T. 51-64°. Contains a trace of bromides.

SCARBOROUGH, England. — Nearly all sulphate of sodium.

SALINS-MOUTIERS, on the line from Paris to Turin.—T. 65-70°. A. 200. Contains traces of iodine, iron, and arsenic.

Class 5.—Mild, with Alkaline Earths.

BRIDES, near Moutiers.—T. 60° to 70°. Iron, arsenic, and iodine.

BRISTOL, England.—T. 74°.

CANNSTADT, on the Neckar.—Contains a great number of springs. Slightly ferruginous, contains large quantity of chloride of sodium, with small quantities of sodium and magnesium sulphates.

LAMOTTE, near Grenoble, France.—A. 475'. M. T. 140° at the source, 106° at the establishments. One of the oldest springs in France.

LEAMINGTON, England.—Cold. Two sources. Ferruginous.

LUCCA, Italy.—T. 88 to 123. Important. Five or six establishments, one of which is reserved for the poor gratuitously. Slightly ferruginous, and contains iron and bromine.

MIERS, France.—Classed by Ingram and Royle as a sulphurous water, but given as a purgative water by Candellé, and stated to contain 180 grains of sulphate of soda. IMP.

NAUHEIM, near Frankfort.—Chiefly chloride of sodium, but an active purgative.

SALINE WATERS.

Without Alkaline or Magnesium Sulphates.

AIRTHREY, Loc., Bridge of Allan.—Contains sulphate of calcium.

ACHSELMANNSTEIN, Bavaria.—A. 1407. Very slightly chalybeate.

ASHBY-DE-LA-ZOUCH.—Used only for baths.

CLIFTON, Loc., Gloucestershire.—T. 74. Used by pulmonary patients, because the climate is mild.

MOERLEITHEN, Peeblesshire.

MONDORF, Luxemberg.—A. 2278. T. 77. Gaseous, and contains small quantities of bromine and arsenic.

SULPHUR WATERS.

Class 1.—*Strong, with well-marked Purgative Action.*

ABANO, Lombardy.—Contains chloride and sulphate o sodium. Used for mud baths. T. 181.

ACQUI, Lombardy.—Similar to the above, and used entirely for mud baths. T. 124.

ALLEVARD, Loc., near Grenoble Station, Goncelin.—Sulphide of calcium, and contains sulphites of soda and magnesium ; also a small quantity of iodides. A. 475 M.

AIX-LES BAINS, Savoie.—Two sources. T. 116°. Contains both soda and magnesium sulphates. In the analyses examined there are no sulphides marked.

AIX-LA-CHAPELLE.—See analyses (Tichborne), p. 173, Liebig, p. 173.

AX (Ariege), France.—The enormous number of fifty-three sources are enumerated in this district. T. 60° to 90°. The sulphide of sodium is given in the three principal sources, as follows :—Bainfort, ·0014 ; Les Canon, ·0021 ; Viguerie, ·002 per cent.

BAREGES.—See analyses (Tichborne), p. 175, Longchamp, p. 175.

BAGNERES-DE-LUCHON, France.—This village is described as being most beautifully situated, and the arrange-

ments are said to be perfect. There are a great number of sulphur waters of every kind. In fact, it is stated that the whole gamut of sulphur waters may be found here. The general character is strongly alkaline. A. 2000°. Imp.

Berka, Saxe-Weimar.—Strong, and very gaseous.

Challes, Loc., between Aix and Chambéry.—Very impotent waters. T. 60. A. 100. Establishments. Said to be one of the most permanent of the sulphur waters. Sulphur exists as sulphide of sodium; and also contains iodide of potassium. Imp.

Castellamare di Stabia, near Naples.—Some of these sulphur waters are ferruginous.

Croft, Yorkshire.—Strong, and associated with sulphate of magnesium.

Fonsanches, Loc., short distance from Nimes.—T. 78. Chiefly sodium sulphides.

Harrogate, England. — Old Sulphur Well. See analyses (Hofmann and Thorp), p. 169.

Harrogate, England, Montpellier.—See analyses, p. 171.

Marlioz, Loc., about 1,000 metres from Aix.—Three sources. They contain traces of iodine and bromine.

Miers, Gourdon, France.—Strong purgative waters.

Saint Gervais (Haute-Savoie, entrance of the valley of Chamounix).—T. 80° to 100°. Also possesses a ferruginous water. The sulphur heated.

Stratford, Victoria.—Aperient.

Strathpeffer, Scotland.—Analysed by Dr. Thompson. Contains both sulphate of sodium and magnesium.

Schinnach, Switzerland.—One of the strongest in Germany. Containing a considerable quantity of sul-

phate of magnesium, and is very highly charged with sulphurated hydrogen, but no sulphides are shown in the analysis published.

Class 2.—Mild, chiefly associated with Alkaline Earths.

AUDINAC, Saint Girons, France.—T. 60°. Some of these waters are ferruginous.

ASKERNE, Yorkshire.—Chiefly lime and magnesia.

BAGNERES DE BIGORRE, Hautes Pyrenées.—A. 527 M. One source only is found of this water. There is a well-conducted establishment. Contains chiefly sulphide with sulphate of calcium. Stated to be slightly ferruginous and arsenical. IMP.

BAGNOLS, LOC., District of Mende.—Alkaline. T. 72° to 93°. A. 850 M.

BONNES.—See analysis (Attfield), p. 176.

CARRATRACA, LOC., near Malaga, Spain.—Mild sulphur water. Used locally as a specific for syphilis.

CAUTERETS, LOC., Hautes Pyrenées.—A. 932 M. Numerous sources, all thermal springs, each having separate establishments. Slightly ferruginous, and consisting largely of silicates; contains chiefly chloride and sulphate of sodium.

DINSDALE, LOC., Northamptonshire.—Associated with calcic sulphates.

EAUX-CHAUDES, near Pau.—T. Minvielle 77° to Le Rey 95°. Six sources. Contains traces of iodine.

ENGHIEN, LOC., short distance from Paris.—Very strong in free sulphuretted hydrogen, but containing no sulphides.

FUMADES, France.—A cold calcic sulphide water.

GREOULX, a short distance from Digne.—Chiefly chloride of sodium and sulphide of calcium. T. 65° to 95°.

LA PRESTE, LOC., near Amelie, France.—A weak sulphate of soda water. T. 100° to 112°.

LABAFSERE, Hautes Pyrenées.—A. 1800. T. 54° to 57°. Containing traces of iodine.

LE VERNET, LOC., some distance from Prades.—T. 90° to 112°. Two establishments.

LISDOONVARNA.—See p. 187.

MOFFAT, England.—According to the analysis, this water contains nothing but the gases and chloride of sodium. This can hardly be correct. Numerous sources.

MOLIGT, LOC., near Prades, France.—T. 70° to 98°. Rather energetic action for mild waters. The highest in sulphide is about 2·8 grains per gallon.

MONTMIRAIL VALQUEYRAS, Vaucluse, France.—The active ingredient in this water is sulphide of calcium, 28 grains per gallon. There are also chalybeate and purgative waters here.

NEUNDORFF, Hesse, Germany. — Mild sulphide of calcium water. Three sources.

PORETTA.—A purgative water.

TABLE WATERS.

Class 1.—*Strongly marked Alkaline reaction, with Salines.*

APOLLINARIS.—See analyses (Tichborne), p. 120 ; (Wanklyn), p. 121. A. 225. IMP.

BIRRESBORN.—A. 1100. See analysis (Fresenius) p. 131. IMP.

GASTEIN, Tyrol Alps.—A. 3200.

GEROLSTEIN.—A. 1200. See analysis (Tichborne), p. 127. IMP.

NIEDERBRONN, near Haguenau.—T. 62°.

POUGUES.—See Mild Chalybeate Waters.

Class 2.—Salines, with mild Alkaline reactions.

ADELHEIDSQUELLE.—See analysis (Pettenkofer), p. 125. IMP.

AIX-EN-PROVENCE.—Celebrated since the time of the Romans. Thermal establishments. T., source Sextus, 93° ; Baret, 70°. IMP.

FACHINGEN, Nassau.—A. 337. Very faintly chalybeate. IMP.

HARZER WATER.—See analysis (Tichborne), p. 119. Contains trace of lithium. IMP.

SELTZER.—See analyses (Tichborne), p. 113 ; Kastner, p. 114. IMP.

VALS DOMINIQUE.—See p. 88. IMP.

WEILBACH, between Mayence and Frankfort.—Establishments for baths in the garden. Salines, alkaline and alkaline earthy carbonates are nearly equally divided in this water. IMP.

Class 3.—Salines, associated with Alkaline Earths.

BELLTHAL.—See analysis (Tichborne), p. 128. A. 400′. IMP.

BUXTON.—T. 81·5°. A new analysis of this water has just been published by J. C. Thresh. It gives in the gallon a total of 27·32 grains, 20 grains of which are bicarbonates of calcium and magnesium, and it contains 3·1 grains of chloride of sodium, small quantities of iron,

manganese, barium, potassium (0·62), sulphate of sodium (0·84), traces of lithium, phosphoric acid, &c. The gases are nitrogen and carbonic acid gas.

BADEN-BADEN.—See analysis (Bunsen), p. 139.

MALVERN, Worcester.—Said to be a beautifully pure water, type of a water which is sometimes called indifferent.

ROSBACH.—See analysis (Wanklyn), p. 136.

SCHWALHEIM.—See analysis (Tichborne), p. 141.

SAINT GALMIER.—See analysis (Tichborne), p. 135.

TAUNUS.—A. 390. See analysis (Taylor), p. 118.

WILHELM'S-QUELLE.—See analyses (Fresenius, and others), p. 129.

Class 4.—Chalybeate.

BILIN.—See Alkaline Waters.

HARROGATE KISSINGEN.—See analysis (Attfield), p. 132.

OREZZA.—A. 1730′. See analysis (Poggiale), p. 138.

POUGUES, on the line from Paris to Nevers.—Two establishments, very celebrated. Contains about $1\frac{1}{2}$ grains per gallon of ferrous carbonate.

CHAPTER XIX.

The Chief Thermal Springs which are used for Baths arranged according to their Temperature.

ALTHOUGH these temperatures are of little use when considering the internal administration of the waters, the indications are of value when considering the use of the waters in the bath. The gaseous contents—another important point, from this point of view—have been given in their proper place.

	Degrees Fahr.
Borcelle	171
Carlsbad	162
Wiesbaden	160
Plombieres	159
Ischia	158
Baden-Baden	155
Bagneres de Luchon (sulphur) ...	154
Ofen	141
Borcette (sulphur)	140
Verney	137

	Degrees Fahr.
Aix-la-Chapelle (sulphur)	131
Cauterets (sulphur)	131
Leuk	124
Bath	120
Teplitz	120
Gastein...	118
Aix-les-Bains (sulphur)	116
Ems	116
Lucca	116
Barèges (sulphur)	111
Lippik	111
Vichy	106
Neuenahr	102
Pfaffers...	100
Wildbad	98
Mondorf	77
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